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STATE DOCUMENTS

SUPPLEMENT

TO
ECONOMIC ANALYSIS
OF
INTERSTATE HIGHWAY 90 ROUTINGS
FROM
BILLINGS TO TOLUCA

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SUPPLEMENT TO
ECONOMIC ANALYSIS OF ALTERNATE LOCATIONS FOR INTERSTATE ROUTE 90
FROM A POINT NEAR BILLINGS TO A POINT NEAR TOLUCA WEST OF HARDIN

November 30, 1961

FOREWORD

Under date of March 15, 1961, an economic analysis was published concerning the investigation of the relative merits of three possible alternate routings for Interstate Highway No. 90 from Billings to Toluca. These were identifed as the North Route, the Middle Route and the South Route, in accordance with the geographic locations of the routes. The South Route is also known as the Bitter Creek Route.

In this original analysis, the North Route followed the line which was selected as the recommended location for Interstate Highway No. 90 between Billings and Hardin in the Section 108(d) and the Section 104(b) 5 reports to Congress. These reports, which were prepared in 1957 and 1960, contained recommended highway locations which were selected on the basis of rather detailed investigations of construction features and construction costs but limited traffic service data. As the recommended locations, they were subject to later modification where more detailed investigations supported a different location.

Following the release of these reports to Congress, a more detailed review was made of the highway location possibilities between Billings and Toluca, and the decision was made to investigate an alternate location on a line directly southeast from Billings, following the drainage course of Bitter Creek and joining the present highway at a point about halfway to Toluca. At the time this decision was made, it was evident that this alternate location would involve greater construction length, but it would involve shorter travel distance for through traffic, and should provide better traffic service. This was identified as the South Route.

At the same time, it was decided to investigate another possible route which followed the location of the North Route in the western section and then followed a new line,between the North and South routes, in the eastern section. This was identified as the Middle Route.

The original report of March 15, 1961 analyzed all routes from the standpoint of construction costs, maintenance costs and motor vehicle operating costs. The overall results were comparatively close for all routes, but the North Route was found to have a slight advantage over the South Route. This advantage amounted to less than 1% in value -- a figure which would be far from conclusive in an analysis of this type which is based to considerable extent on estimated data. In effect, the North and South routes were considered to be equal insofar as the results of the basic analysis were concerned, and it was necessary to consider other factors which were beyond the area of the analysis.

A review of these other considerations produced the following features which supported the South Route:

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1. It was estimated that it would require about six years to complete construction on any of the alternate routes between Billings and Toluca. If the North or Middle routes were to be constructed, they would be of little service until they were completed throughout their entire length and could be used by through traffic. Construction on the South Route between Billings and the Pryor Creek vicinity could be completed in about three years. At the end of the three year period, the through traffic could be served by a connection to the present highway, and this traffic would enjoy a substantial advantage in being able to use the new Interstate highway in place of the present tortuous road between Billings and Pryor Creek. These benefits were not credited to the South Route in the original analysis.

2. The traffic analysis showed that the North and Middle routes would provide the best service to traffic originating in the area to the east of Billings. The South Route would serve best the traffic that originated in Billings and the area to the west. Indications are that future growth will be greater in Billings and the area to the west, and for this reason, it was felt that future,expanded traffic would be served best by the South Route.

3. If the North or Middle routes were to be constructed, it would be necessary to keep the present highway in service to serve local traffic and traffic from intersecting roads. Most of the present highway could be abandoned or relegated to frontage road status if the South Route were to be constructed. One indeterminate factor involved the probability that it would be necessary to reconstruct the present highway between Pryor Creek and the Lockwood area east of Billings to serve the remaining traffic off the Interstate highway if the North or Middle routes were to be constructed. This section of the present highway is about 30 years old and has a substandard alignment, and it is probable that it would be best to reconstruct this section of highway in place of attempting to keep it in service through maintenance practices. Such construction costs were not included in the original analysis as a charge against the North and Middle routes.

On the basis of the analysis and these other considerations, the State Highway Commission approved the South Route as the recommended location for the Interstate highway between Billings and Toluca. A public hearing on the matter was held in Billings on May 9, 1961.

Following the hearing, it was suggested that a more detailed investigation be conducted with regard to the construction features and related construction costs of the South Route. This suggestion was in order for the reason that the methods used in selecting the line and developing the construction costs for the South Route were not as precise as the methods used for the North Route.

This supplement to the original analysis describes the procedures followed in developing revised construction costs for the South Route, and it presents comparative data for the Revised South Route in relation to similar data for the North, Middle and South routes, as contained in the original analysis.

LOCATION PROCEDURE

Topographic maps were prepared by a Kelsh plotter at 1" = 400' with a 10' and 20' contour interval. The alignment shown in this report is the result of investigating many alternate locations. Profiles were plotted for all lines, and preliminary cut and fill quantities were determined by means of curves that related earthwork volumes to depth of cut and height of fill, and percent of cross slope. On the basis of volumes of cut and fill developed in this manner, the least feasible lines were eliminated. Thus the alignment shown in this report is the best location studied.

ESTIMATING PROCEDURE

The cost of utility adjustments was estimated on the basis of a field review.

From the aerial maps, cross-sections were taken at appropriate intervals and grades and typical sections were entered in the IBM 650 electronic computer to obtain the earthwork quantities. The cost of grading includes overhaul, watering and rolling.

The cost of drainage structures, 72" in diameter and under, was based on average costs per mile. The drainage structures, over 72" in diameter, were recommended by the Hydraulics Division and estimated individually.

Stockpasses were included where major land-use areas were segregated.

Base and surfacing quantities were based on an average cost-per-mile from similar design sections.

The cost of interchanges includes structure, crossroad relocation, grading and draining of ramps, adjustment of utilities, guardrail, curbs, signing and traffic controls.

The estimated cost of the highway separations, the railroad separation, and the Pryor Creek and Fly Creek bridges was based on average unit prices per square foot of deck area. The cost estimate of the Yellowstone River Bridge was made by the Bridge Division.

Guardrails, fences, and signs were estimated on a cost-per-mile basis.

Right-of-way costs are based on a field appraisal by the Right-of-Way Division.

Preliminary engineering, construction engineering, and contingencies are estimated as 14.8 percent of the construction cost.

The following table shows comparative construction features for the North, Middle, Original South and Revised South routes:

CONSTRUCTION FEATURES

FEATURES	NORTH	MIDDLE	ORIGINAL SOUTH	REVISED SOUTH
Construction length	28.9	29.0	34.8	34.8
Travel length	35.2	35.3	34.8	34.8
Miles of 4-lane	4.9	4.9	0.0	0.0
Number of interchanges	3	2	1*	1*
Number of highway separations	3	4	0	0
Number of R.R. separations	1	1	1	1
Number of bridges	2	2	3	3
Miles of new frontage road	11.3	4.8	1.2	0**
Number of grades over 3 percent	8	6	5	0
Total rise and fall in feet	2,675	2,605	2,425	2,265
Maximum elevation	3,925	3,900	3,775	3,730***

* Pryor Creek interchange. Twenty-Seventh Street interchange is not included as it would be required to serve Billings regardless of route selected between Billings and Toluca

** A change in alignment eliminates need for this frontage road.

*** A change in alignment lowered this elevation.

It may be noted that only one interchange (the Pryor Creek interchange) is included for the Original South Route and the Revised South Route. The Twenty-Seventh Street interchange is omitted for the reason that this interchange would be required to serve traffic to and from Billings regardless of the Interstate highway location selected between Billings and Toluca. A more elaborate interchange would be required, however, to connect with the South routes, and the cost of this extra construction is charged against the South routes.

This table also shows that there is a reduction in both the maximum elevation and the amount of rise and fall for the Revised South Route, as compared with the Original South Route. As the result of the location procedure for the Revised South Route, it was possible to develop a location which crossed the divide between Bitter Creek and Pryor Creek at a lower point than the one selected for the Original South Route. This lower elevation, together with an improved gradeline, permitted a related reduction in the total rise and fall involved for the Revised South Route.

TABLE No. 2 (Revised 11-30-61)

COMPARISON OF TOTAL AND ANNUAL CONSTRUCTION COSTS

COST CATEGORY	ESTIMATED SERVICE LIFE	NORTH ROUTE TOTAL COST	NORTH ROUTE ANNUAL COST	MIDDLE ROUTE TOTAL COST	MIDDLE ROUTE ANNUAL COST	SOUTH ROUTE TOTAL COST	SOUTH ROUTE ANNUAL COST	REVISED SOUTH ROUTE TOTAL COST	REVISED SOUTH ROUTE ANNUAL COST
Grade, drain, stockpasses	40 years	$2,589,000	$ 64,725	$3,160,000	$ 79,000	$2,690,000	$ 67,250	$1,797,000	$ 44,925
Base & surfacing	20 years	1,835,000	91,750	1,781,000	89,050	1,853,000	92,650	1,844,000	92,200
Railroad separations	50 years	89,000	1,780	89,000	1,780	89,000	1,780	89,000	1,780
Highway separations	50 years	33,000	660	33,000	660	- - -	- - -	- - -	- - -
Interchanges	50 years	868,000	17,360	707,000	14,140	644,000	12,880	586,000	11,720
Bridges	50 years	115,000	2,300	114,000	2,280	971,000	19,420	825,000	16,500
Utility adjustments	40 years	- - -	- - -	- - -	- - -	- - -	- - -	12,000	300
Guardrail, fencing, signing	20 years	326,000	16,300	432,000	21,600	349,000	17,450	367,000	18,350
Subtotal - construction cost		5,855,000	194,875	6,316,000	208,510	6,596,000	211,430	5,520,000	185,775
Right-of-way	50 years	115,000	2,300	94,000	1,880	204,000	4,080	204,000	4,080
Engineering & contingencies	40 years	867,000	21,675	935,000	23,375	973,000	24,325	817,000	20,425
TOTAL COST		$6,837,000	$218,850	$7,345,000	$233,765	$7,773,000	$239,835	$6,541,000	$210,280
AVERAGE SERVICE LIFE		31.24 years		31.42 years		32.40 years		31.11 years	

Remarks: Since the interchanges near the Pinehill Subdivision are required only if the North or Middle Routes are built, the full cost of these interchanges is charged against the respective routes. Regardless of the Interstate highway location chosen between Billings and Toluca, it will be necessary to construct an interchange at South 27th Street to provide access to the city; however, if the South Route is constructed, it will be necessary to provide a more elaborate interchange at South 27th Street, and the extra cost of this facility is charged against the South Route.

It may also be noted that the location for the Revised South Route permitted the elimination of any grades over 3 percent.

CONSTRUCTION COSTS

The enclosed table is a revision of Table No. 2 on page 9 of the original report. This new table shows a comparison of total and annual construction cost data for the North Route, the Middle Route, the Original South Route and the Revised South Route.

It may be observed from this table that both the total construction costs and the annual construction costs for the Revised South Route are lower than similar costs for the Original South Route. These reductions are realized because of the improved location for the Revised South Route. The construction length remains the same for both routes.

Utility adjustment costs, as shown for the Revised South Route include the costs of moving existing power and telephone lines to provide space for the revised location. Utility adjustments were not involved for the other routes.

The differences in construction costs and the reasons for the differences are shown in the following table:

COMPARISON OF ORIGINAL AND REVISED SOUTH ROUTE COST ESTIMATES

COST IN $1,000

Item	Original South	Revised South	Difference	Reason for change
Utilities	0	12	+12	Item not included in original estimate
Grading	2,407	1,549	-858	Better alignment for less quantities
Drainage	212	181	-31	Fewer large pipes in Bitter Creek drainage
Stockpasses	71	67	-4	Changes in segregation require fewer but larger stockpasses
Base	729	724	-5	Elimination of frontage road
Surface	1,124	1,120	-4	Elimination of frontage road
27th Street Interchange	439	439	0	Estimate not changed

Item	Original South	Revised South	Difference	Reason for change
Other Interchange	205	148	-57	Pryor Road interchange changed to a local road over interchange
Bridges	971	825	-146	Lower cost of Yellowstone River Bridge due to additional information reducing quantities in channel change.
R.R. Separation	89	89	0	Estimate not changed
Guardrail	135	152	+17	Greater quantity required
Fencing	200	200	0	Estimate not changed
Signing	14	14	0	Estimate not changed
Construction subtotal	6,596	5,520	-1,076	
Right-of-Way	204	204	0	Estimate not changed
Engineering & Contingencies	973	817	-156	14.8 percent of construction subtotal
TOTAL	7,773	6,541	-1,232	

SUMMARY

The enclosed table summarizes the annual construction costs, the annual maintenance costs and the annual vehicle operating costs for the three original routes and the Revised South Route. This table is supplementary to the summary table shown on page 17 of the original report.

This table shows that the Revised South Route has annual overall costs of $29,555 less than the Original South Route and $16,869 less than the North Route. This is a reversal of the situation shown in the table on page 17 of the original report wherein the North Route had an advantage of $12,686 in annual savings as compared with the Original South Route. Whereas the original report showed that the annual overall costs for the North Route were 0.37 percent less than the Original South Route, the revised table shows that the annual overall costs for the Revised South Route are 0.49 percent less than those for the North Route.

SUMMARY OF ANNUAL CONSTRUCTION, MAINTENANCE AND OPERATING COSTS

	PRESENT CONDITIONS	NORTH ROUTE	MIDDLE ROUTE	ORIGINAL SOUTH ROUTE	REVISED SOUTH ROUTE
ANNUAL CONSTRUCTION COSTS	$	$ 218,850	$ 233,765	$ 239,835	$ 210,280
ANNUAL MAINTENANCE COSTS	60,820	109,870	107,320	91,120	91,120
SUBTOTAL	60,820	328,720	341,085	330,955	301,400
ANNUAL OPERATING COSTS	3,597,848	3,085,804	3,094,555	3,096,255	3,096,255
TOTAL OF ALL COSTS	$3,658,668	$3,414,524	$3,435,640	$3,427,210	$3,397,655
ANNUAL SAVINGS IN FAVOR OF REVISED SOUTH ROUTE	$261,013	$16,869	$37,985	$29,555	- - - -
	7.68%	0.49%	1.12%	0.87%	

These changes occur entirely as the result of reduced construction costs for the Revised South Route because of the improved location. Although the elimination of grades over 3 percent and the lower elevation for the Revised South Route would produce a minor reduction in unit vehicle operating costs, the amount of the reduction would not be of sufficient importance to warrant recomputation of the vehicle operating costs.

The table for CONSTRUCTION FEATURES shows that 1.2 miles of frontage road have been eliminated in the location for the Revised South Route. At an annual maintenance cost of $500 per mile, this would reduce the maintenance costs for the Revised South Route by $600 per year. This figure is also too small to warrant a revision of the maintenance cost figures shown for the Original South Route.

The benefit/cost ratio figures, shown on page 18 of the original report, are repeated below to include the benefit/cost ratio for the Revised South Route.

$$\frac{\text{Benefits}}{\text{Costs}} - \frac{\text{Present Operating Costs minus New Operating Costs}}{\text{New Constr. \& Mtce. Costs minus present Mtce. Costs}} = \text{Ratio}$$

NORTH ROUTE

$$\frac{\$3,597,848 - \$3,085,804}{\$\ 328,720 - \$\ 60,820} = \frac{\$512,044}{\$267,900} = 1.9113 \text{ Ratio}$$

MIDDLE ROUTE

$$\frac{\$3,597,848 - \$3,094,555}{\$\ 341,085 - \$\ 60,820} = \frac{\$503,293}{\$280,265} = 1.7958 \text{ Ratio}$$

SOUTH ROUTE

$$\frac{\$3,597,848 - \$3,096,255}{\$\ 330,955 - \$\ 60,820} = \frac{\$501,593}{\$270,135} = 1.8568 \text{ Ratio}$$

REVISED SOUTH ROUTE

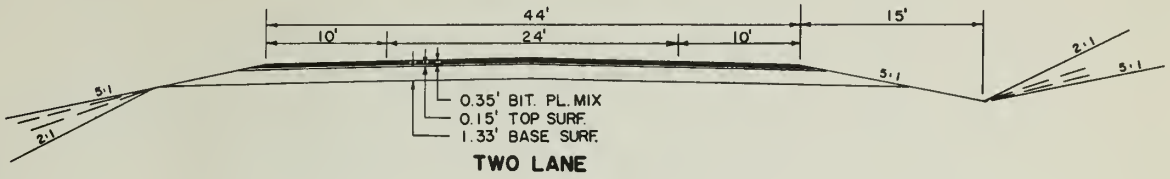
$$\frac{\$3,597,848 - \$3,096,255}{\$\ 301,400 - \$\ 60,820} = \frac{\$501,593}{\$240,580} = 2.0849 \text{ Ratio}$$

The previous table in the original report showed that the North Route had the most favorable benefit/cost ratio, with $1.91 being returned in benefits for each $1.00 spent on construction and maintenance. This table now shows that the Revised South Route has the most favorable ratio, with $2.08 being returned in benefits for each $1.00 invested in construction and maintenance.

In conclusion, it is evident that the review of the location for the South Route has resulted in a better line, with reduced construction costs as compared to the Original South Route. This reduction in construction costs has placed the Revised South Route in the position of being the most favorable routing from the standpoint of overall annual costs. It also produces the most favorable benefit/cost ratio for the Revised South Route.

These conclusions provide further support for the previous conclusion that the South Route (Bitter Creek Route), as revised, would be the best location for the new Interstate highway between Billings and Toluca.

TYPICAL SECTION



TWO LANE

LEGEND

EXISTING FEATURES

PAVED ROAD
TRAIL
BRIDGE
STREAM
INTERMITTENT STREAM
IRRIGATION DITCH
DEPRESSION

RAILROAD
RAILROAD OVERPASS

SPOT ELEVATION X 3330
BUILDINGS
UTILITY POLE

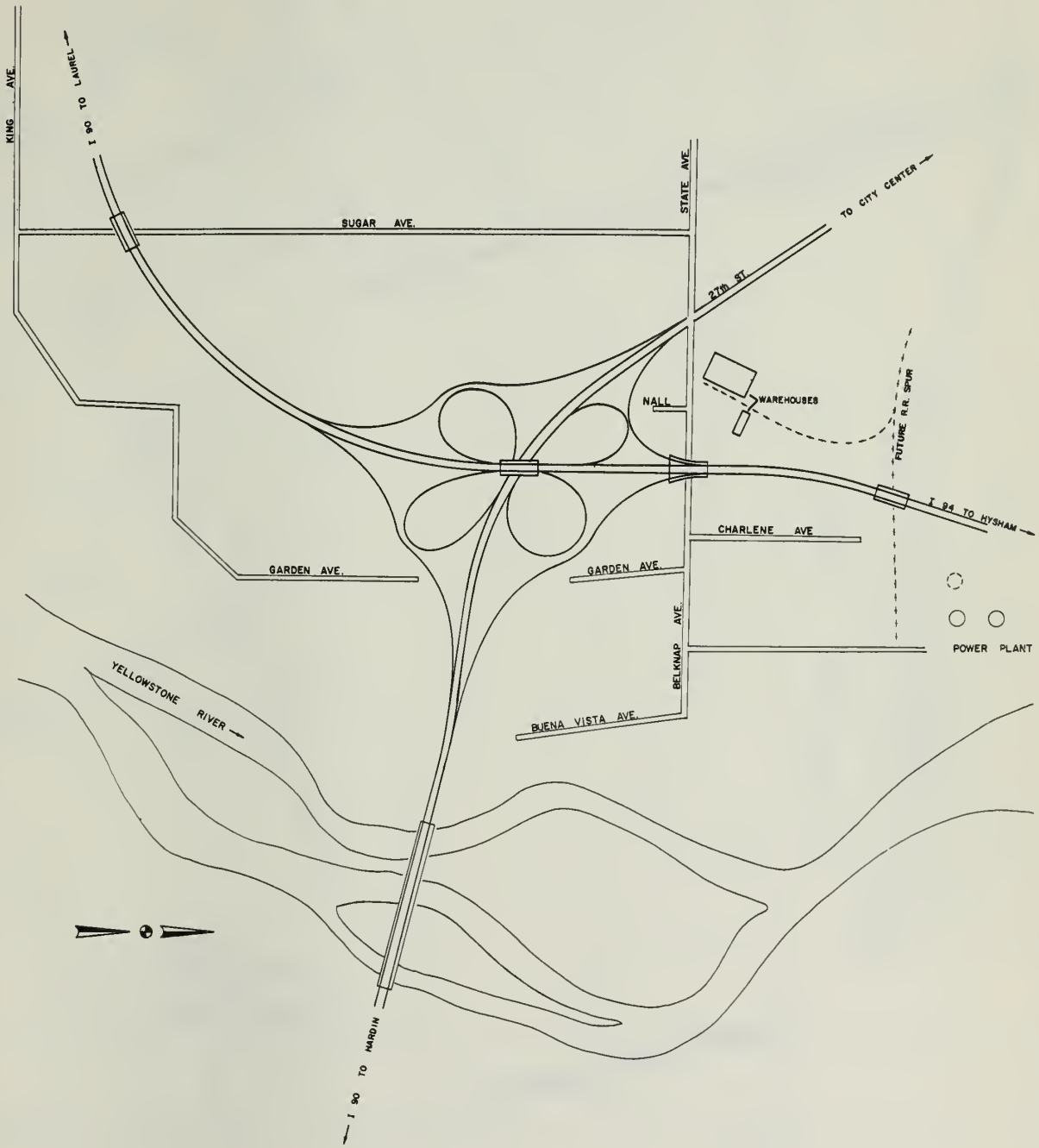
RESERVOIR & DAM

PROPOSED FEATURES

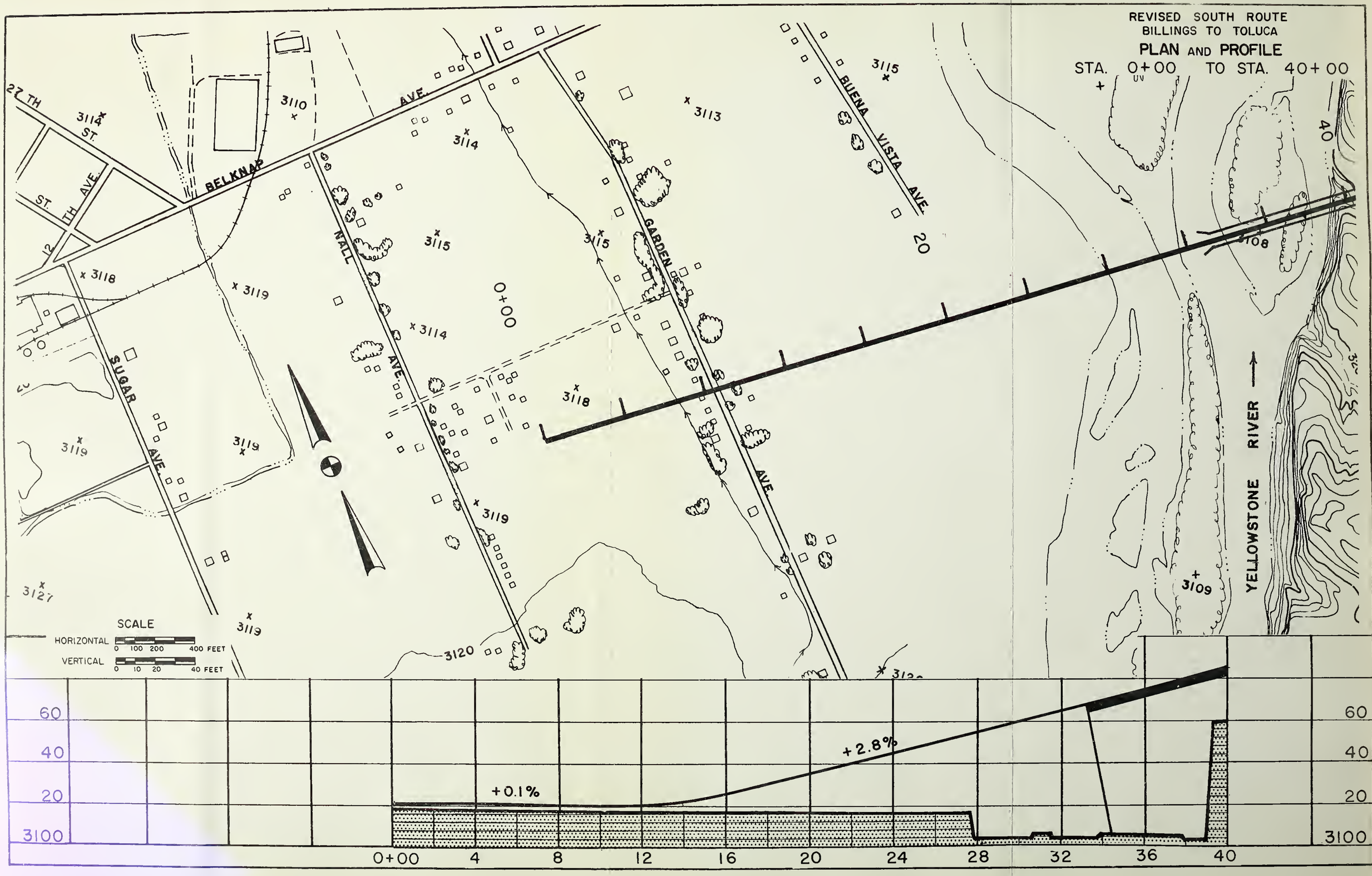
INTERSTATE HIGHWAY
INTERSTATE BRIDGE
CHANNEL CHANGE

27TH ST. INTERCHANGE

SOUTH ROUTE



REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 0+00 TO STA. 40+00



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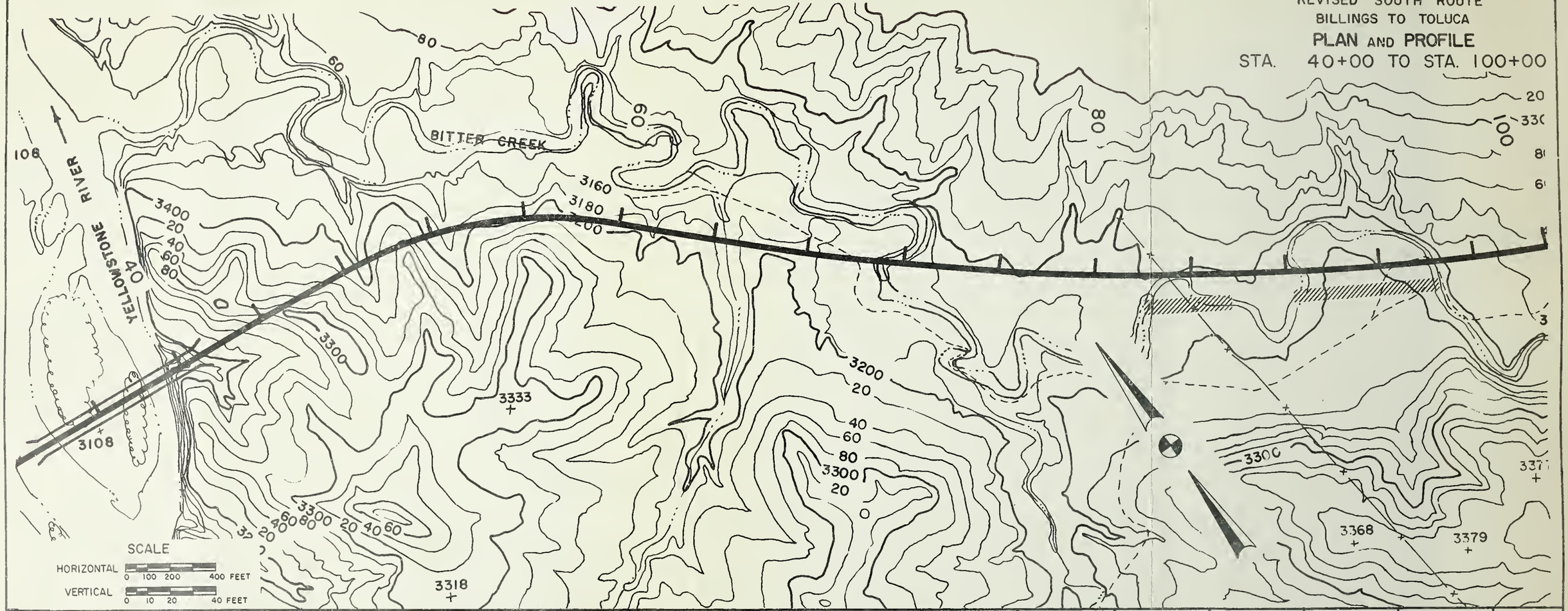
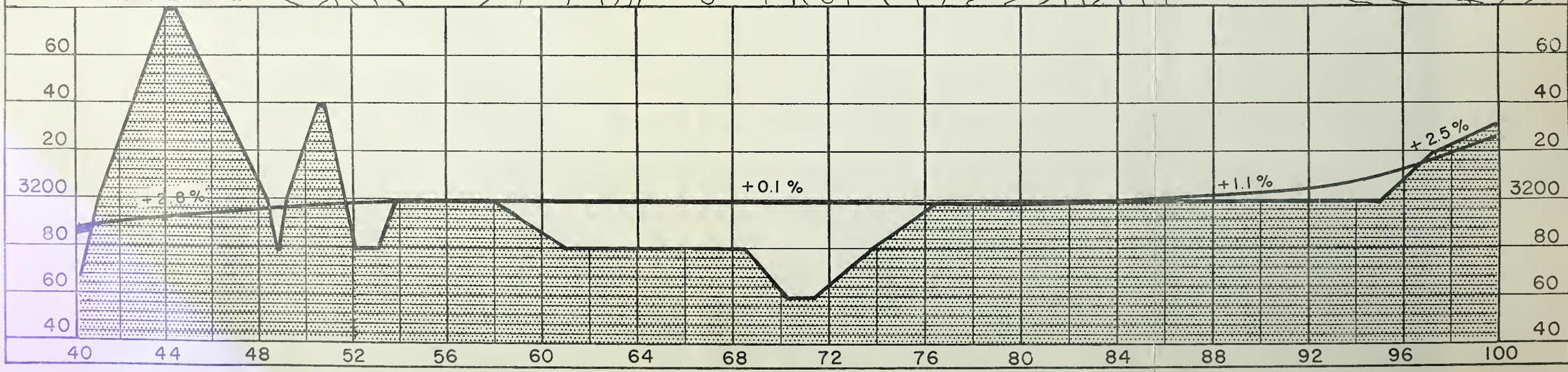




REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 100+00 TO STA. 160+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

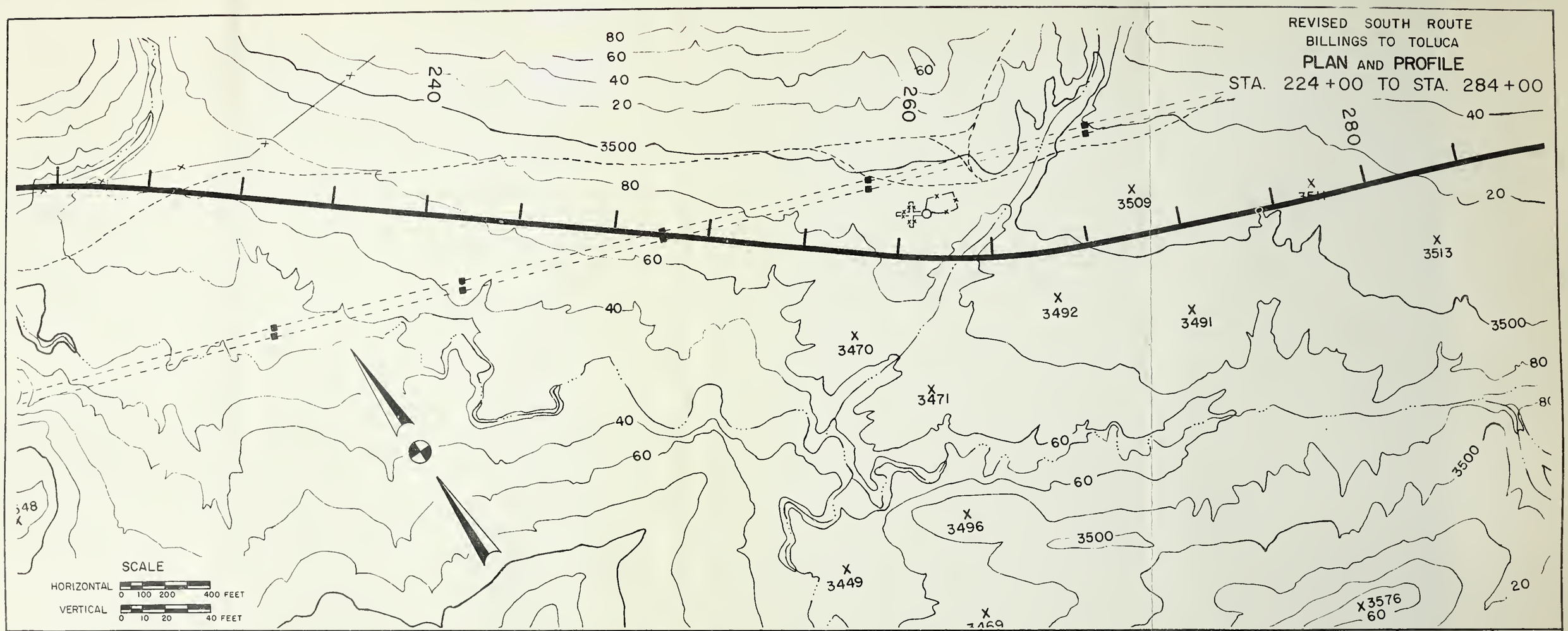
+2.5 %
+1.0 %
+2.0 %

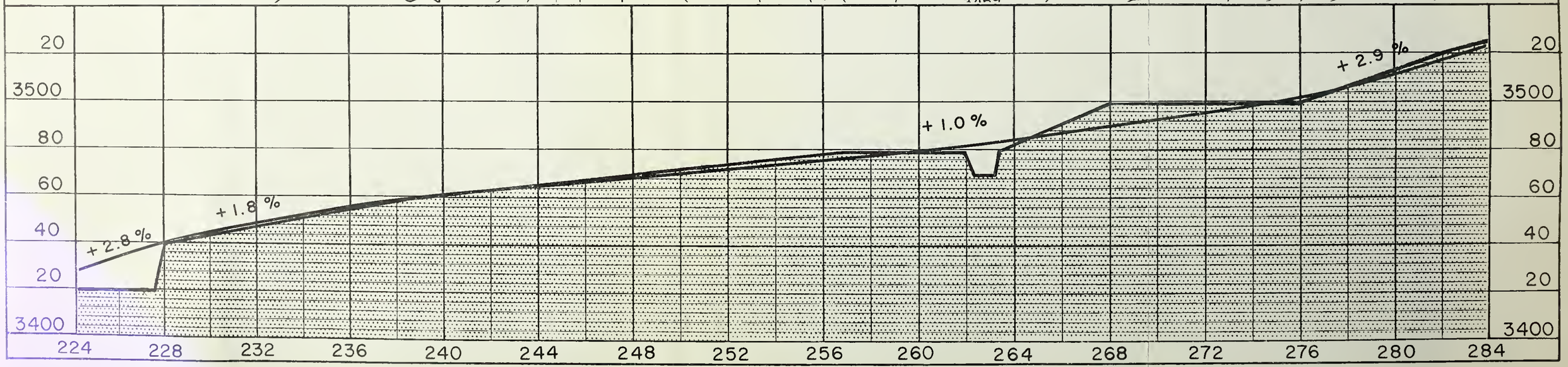
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 160+00 TO STA. 220+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

+2.0 %
+1.0%
+2.8 %

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 224+00 TO STA. 284+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 284+00 TO STA. 344+00

SCALE
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VERTICAL 0 10 20 40 FEET

+ 2.9 %
+ 0.9 %

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 344+00 TO STA. 404+00

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Reservoir

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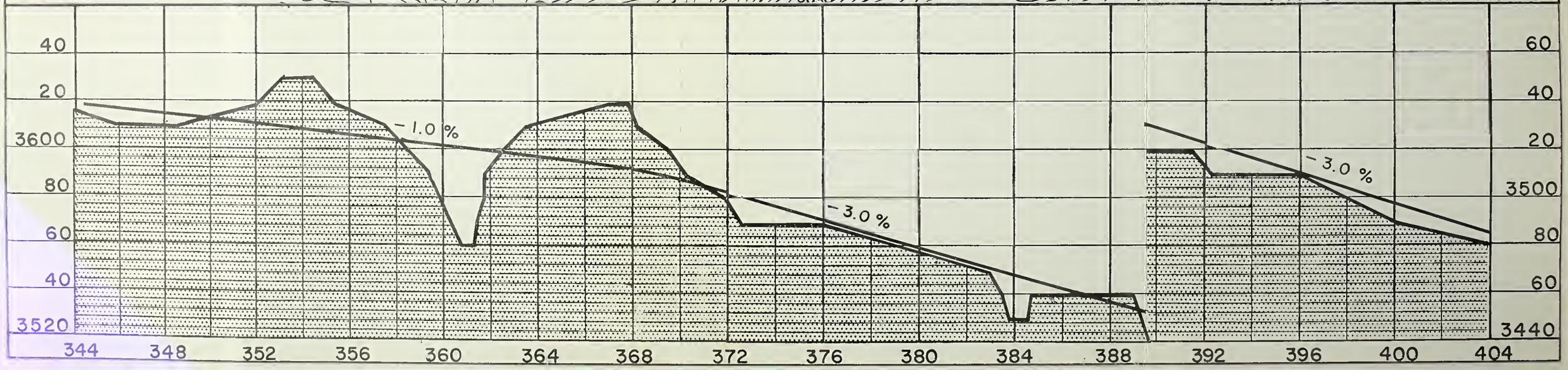
3700 3600 3550 3500 3630 3380 360 400



REVISED SOUTH ROUTE
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PLAN AND PROFILE
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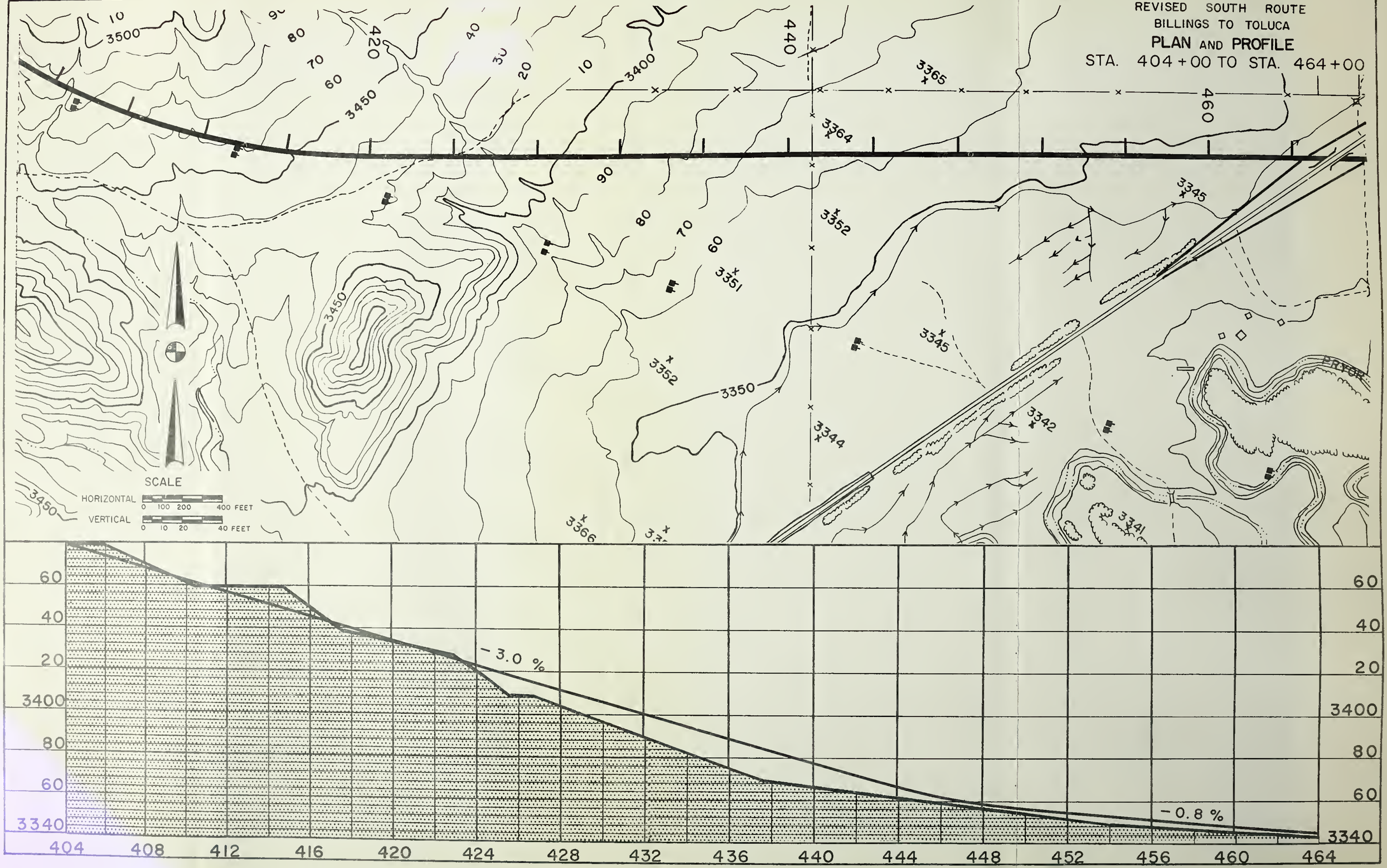


REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 464 + 00 TO STA. 524 + 00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

PRYOR CREEK

− 0.8 %

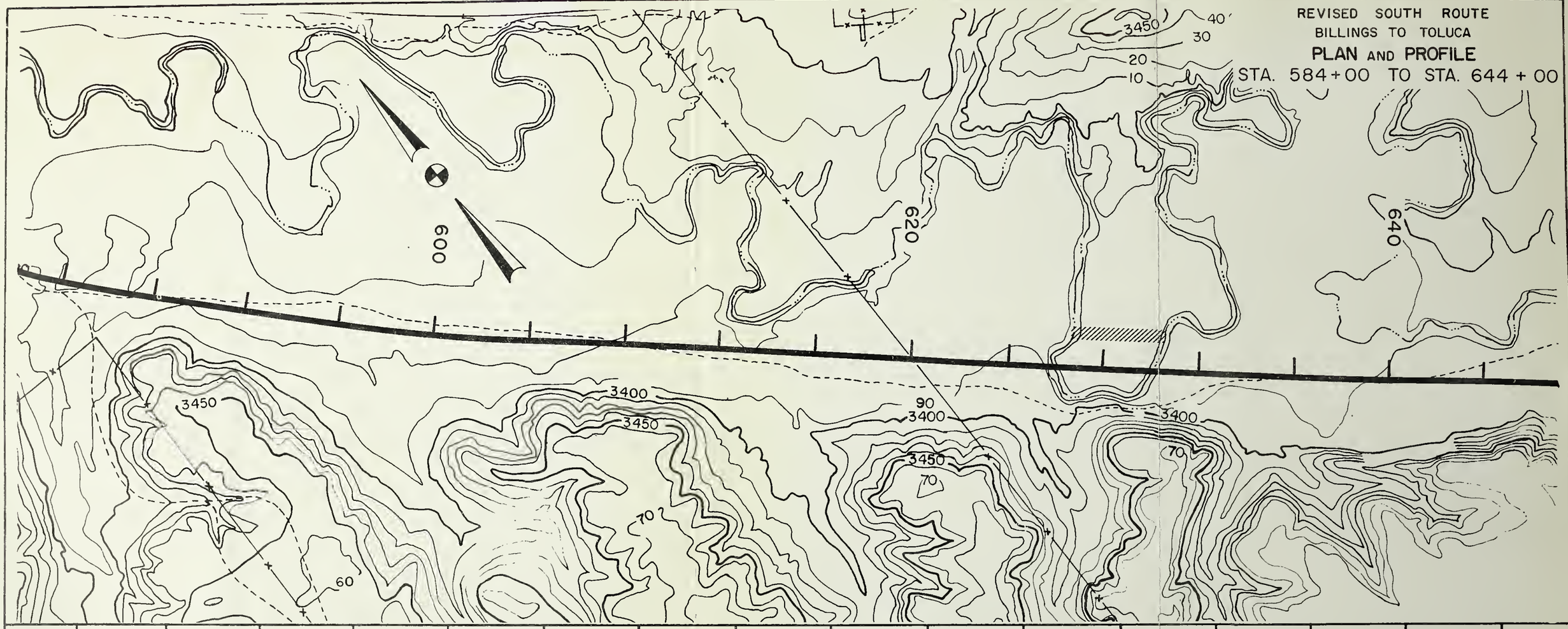
+ 3.0 %

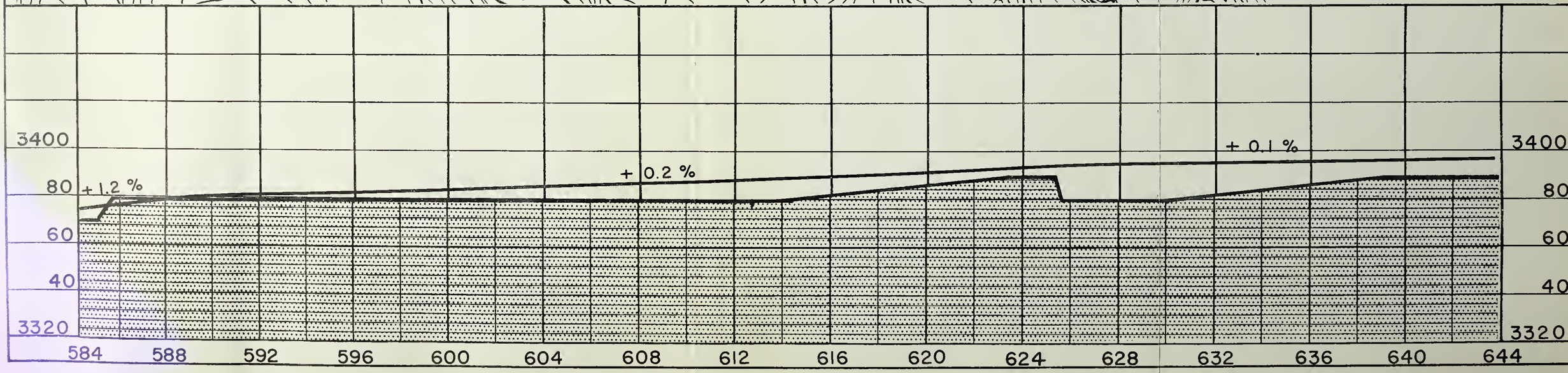
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 524+00 TO STA. 584+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

-3.0 %
+ 1.2 %

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 584+00 TO STA. 644+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 644+00 TO STA. 704+00

SCALE

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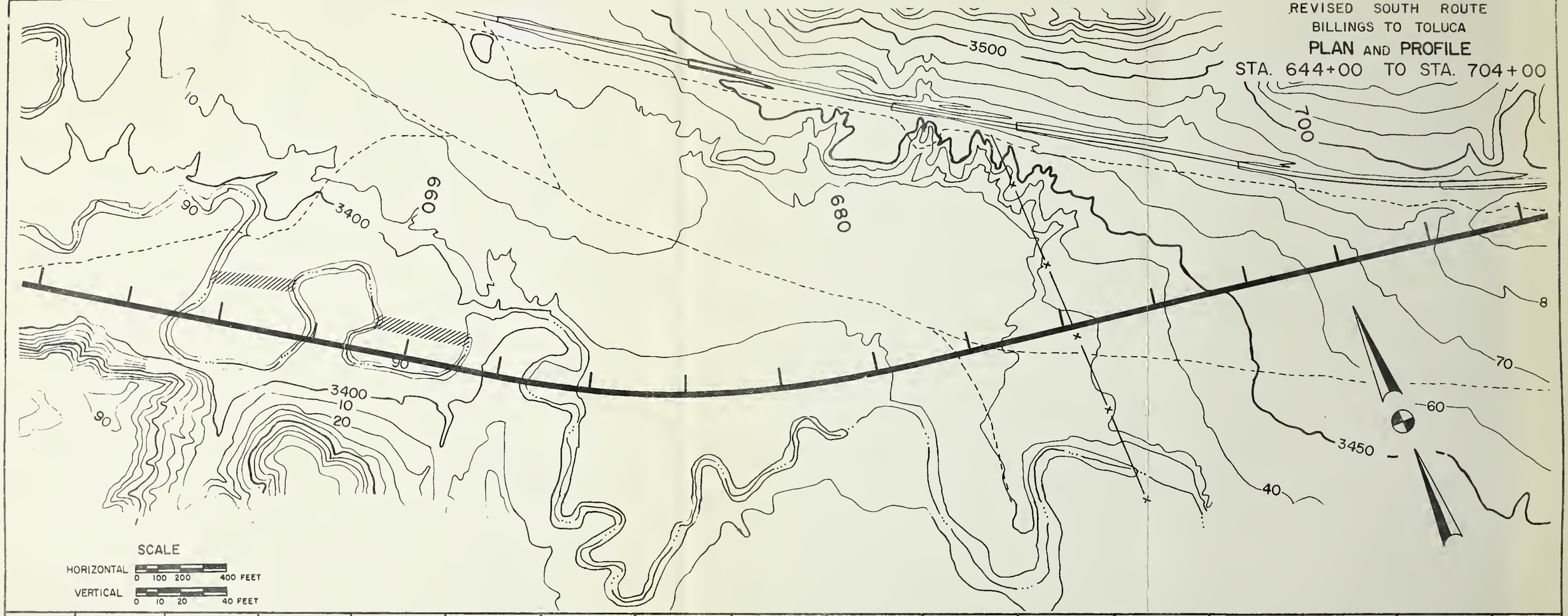
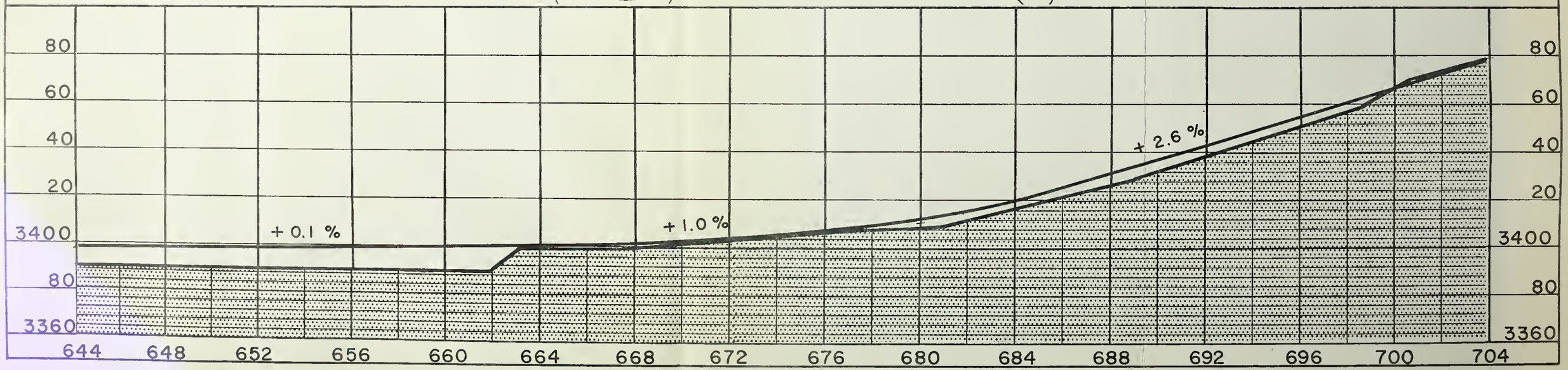
VERTICAL 0 10 20 40 FEET





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 704+00 TO STA. 764+00

U.S. 87

720 740 760

3550 3500 3530

Cultivated

Cultivated

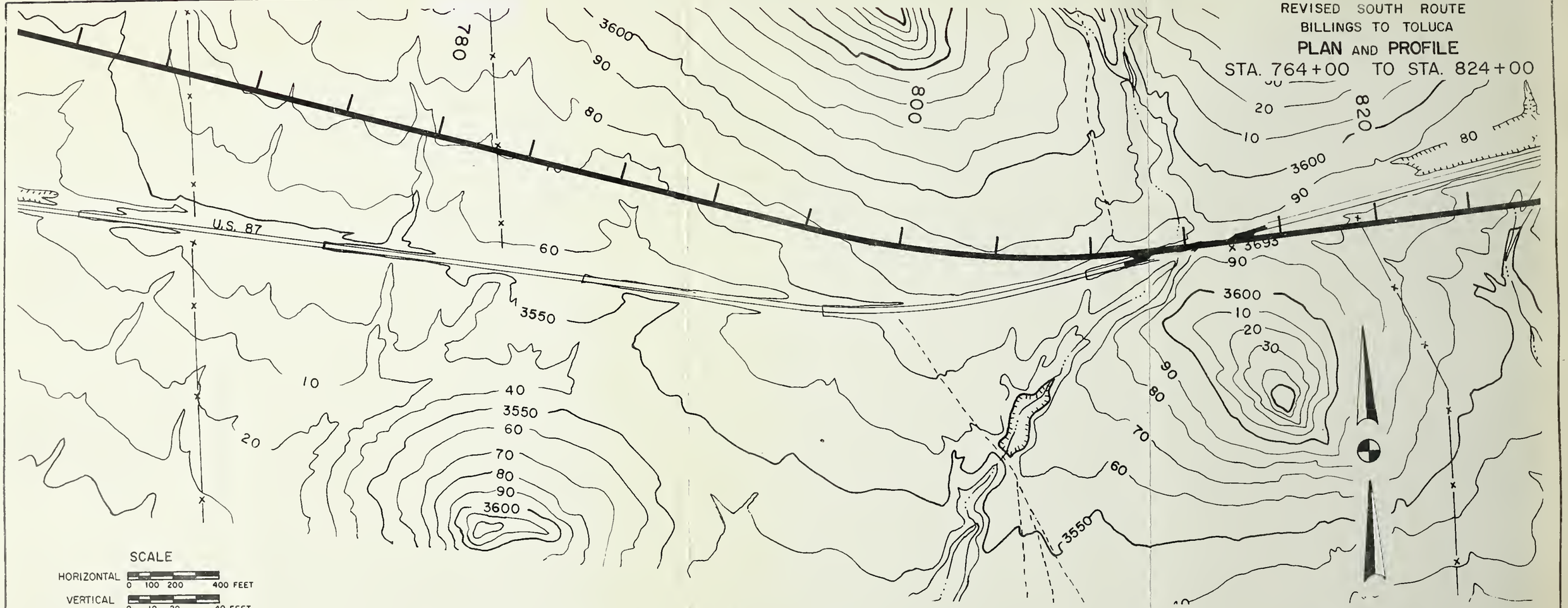
SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

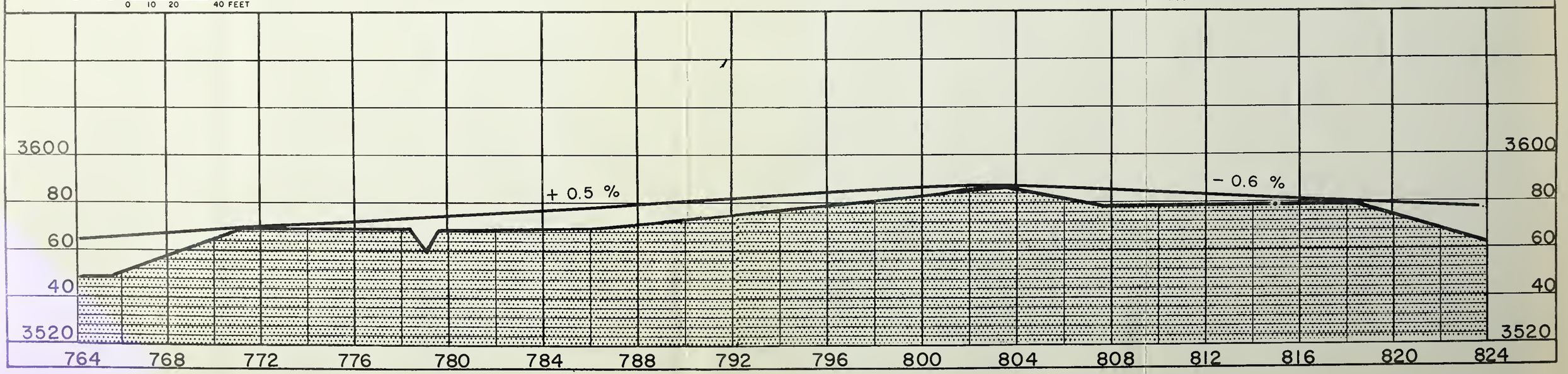
+ 2.6 %
+ 1.7 %
+ 0.5 %

60 40 20 3500 3480

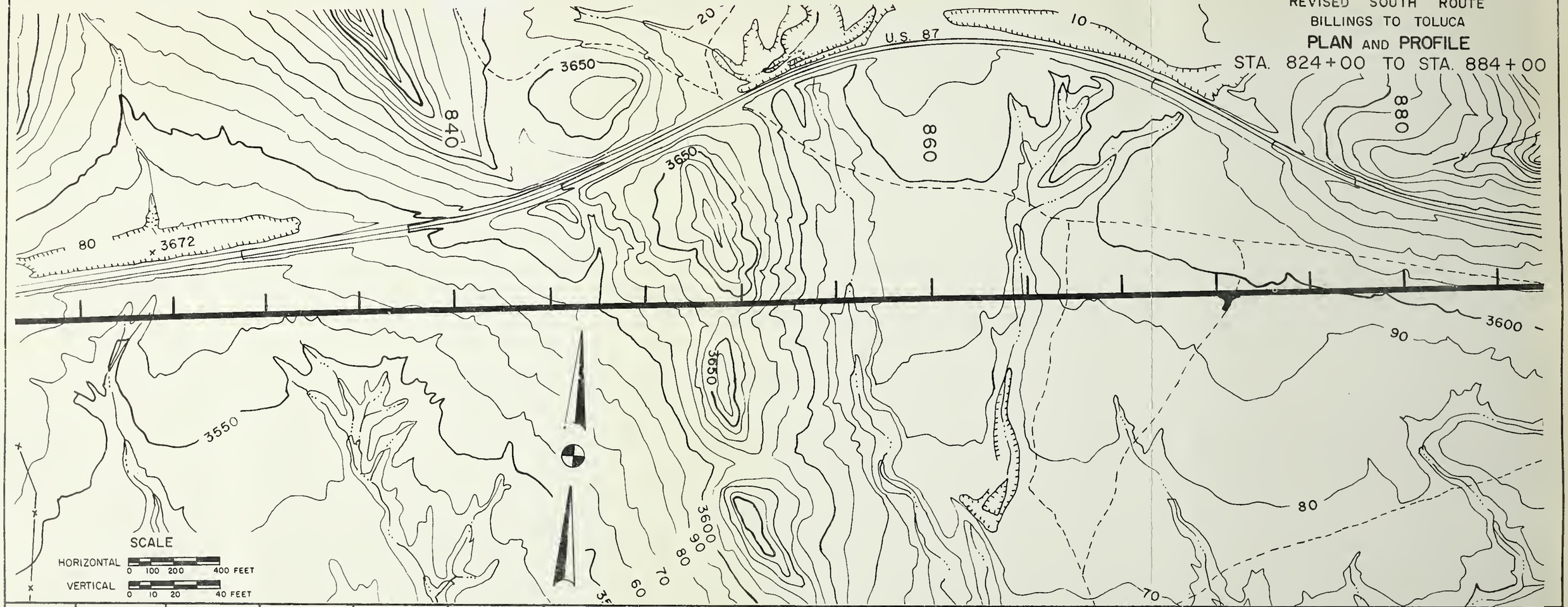
704 708 712 716 720 724 728 732 736 740 744 748 752 756 760 764

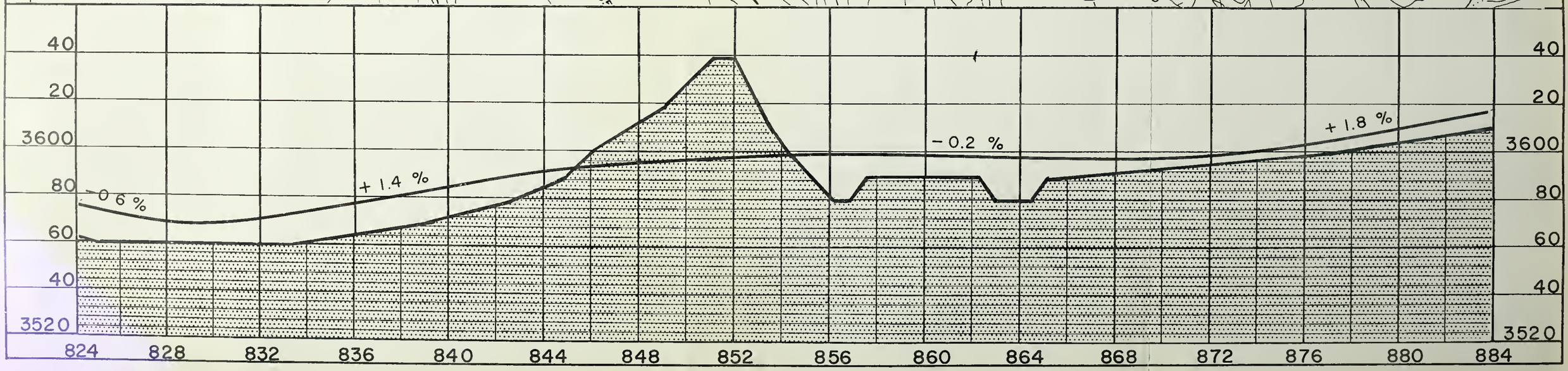
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 764+00 TO STA. 824+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 824+00 TO STA. 884+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 884+00 TO STA. 944+00

Cultivated

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

+1.8 %
+3.0 %

884 888 892 896 900 904 908 912 916 920 924 928 932 936 940 944

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 944+00 TO STA. 1004+00

Cultivated

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

−2.5 %

−1.0 %

944 948 952 956 960 964 968 972 976 980 984 988 992 996 1000 1004

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1004+00 TO STA. 1064+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

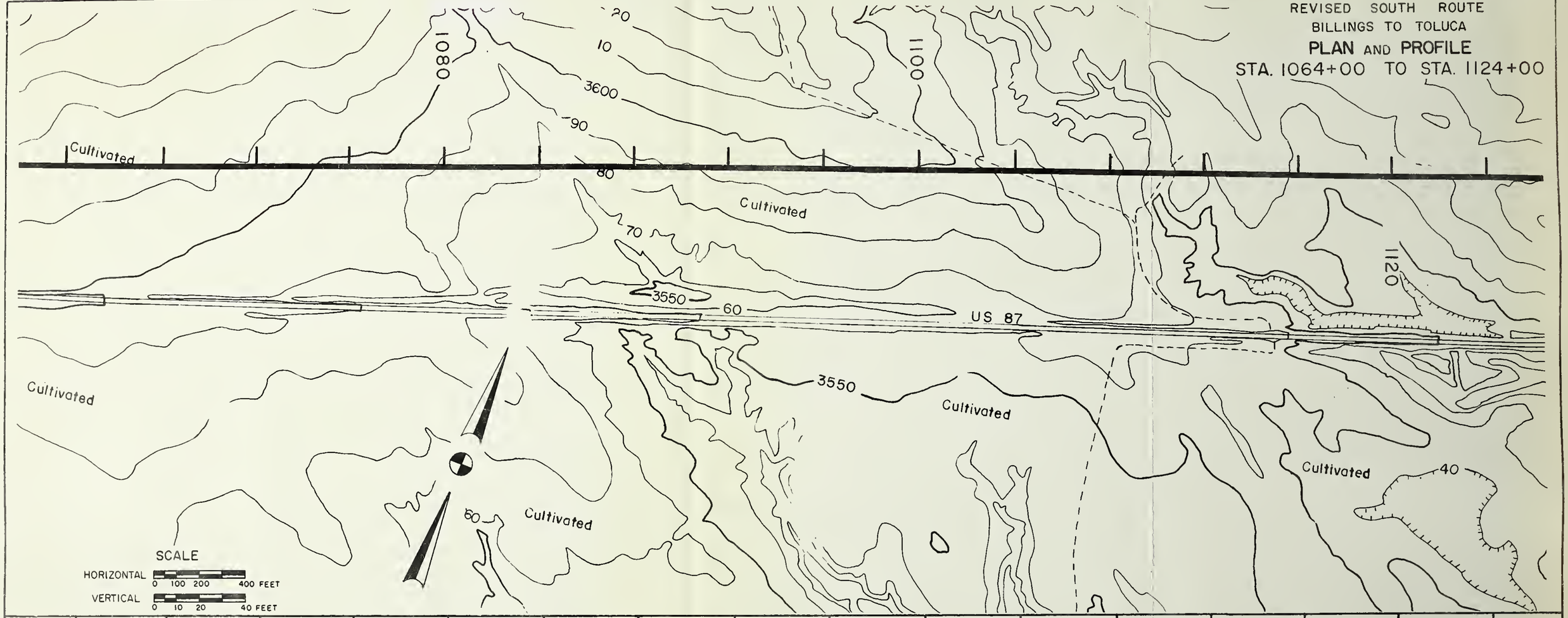
Cultivated

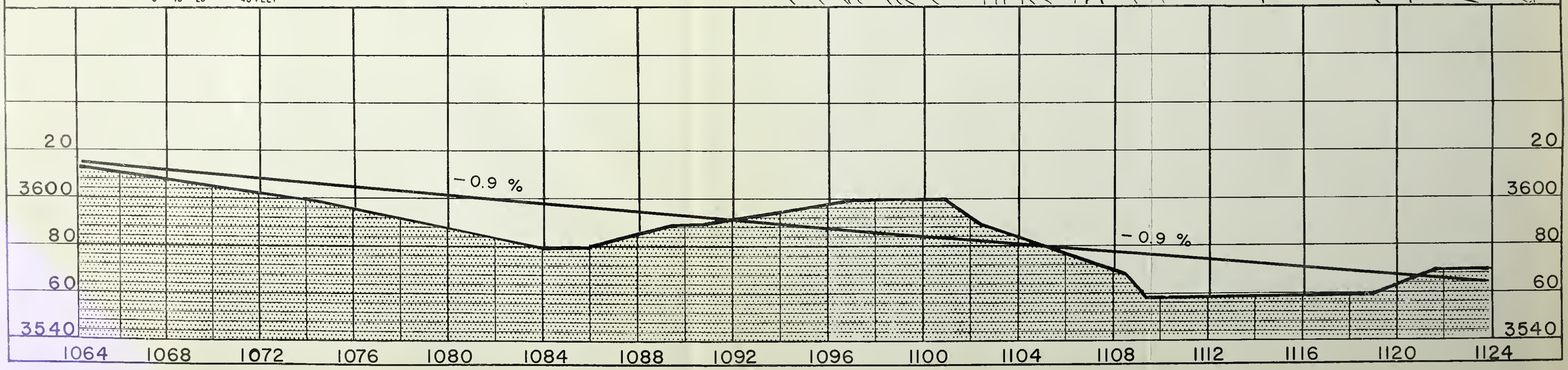
− 1.0 %

+ 1.2 %

− 0.9 %

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1064+00 TO STA. 1124+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1124+00 TO STA. 1184+00

Cultivated

Grazing

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET

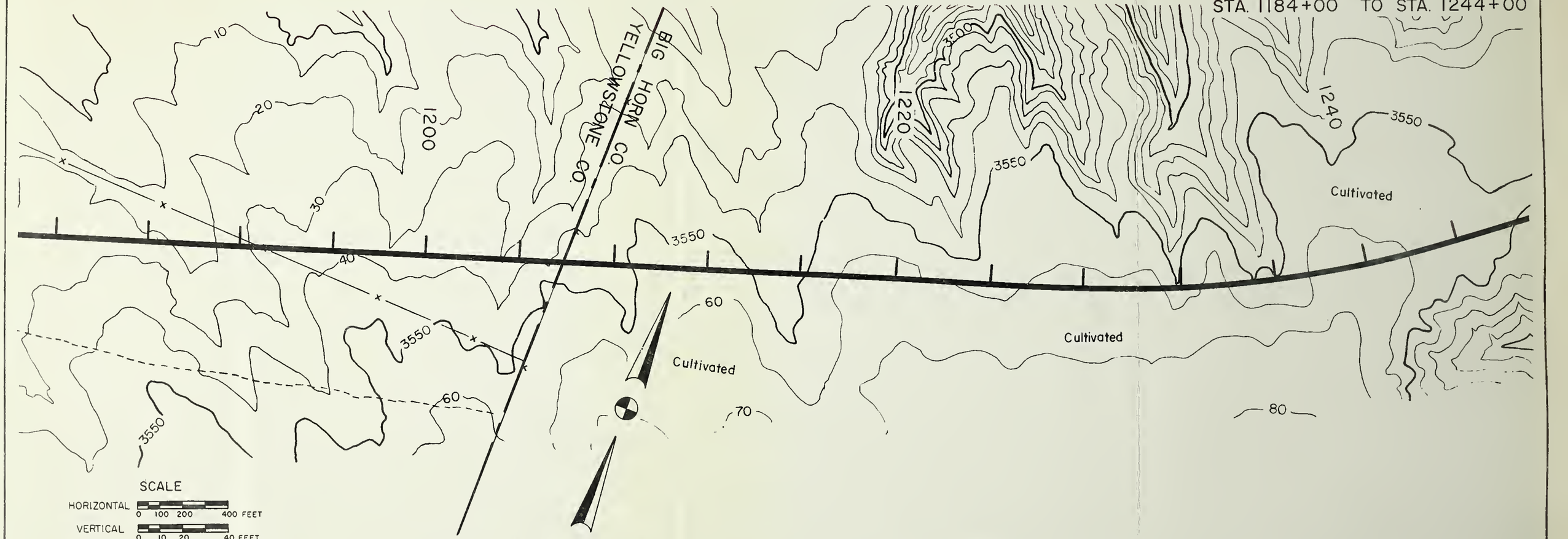
− 2.5 %

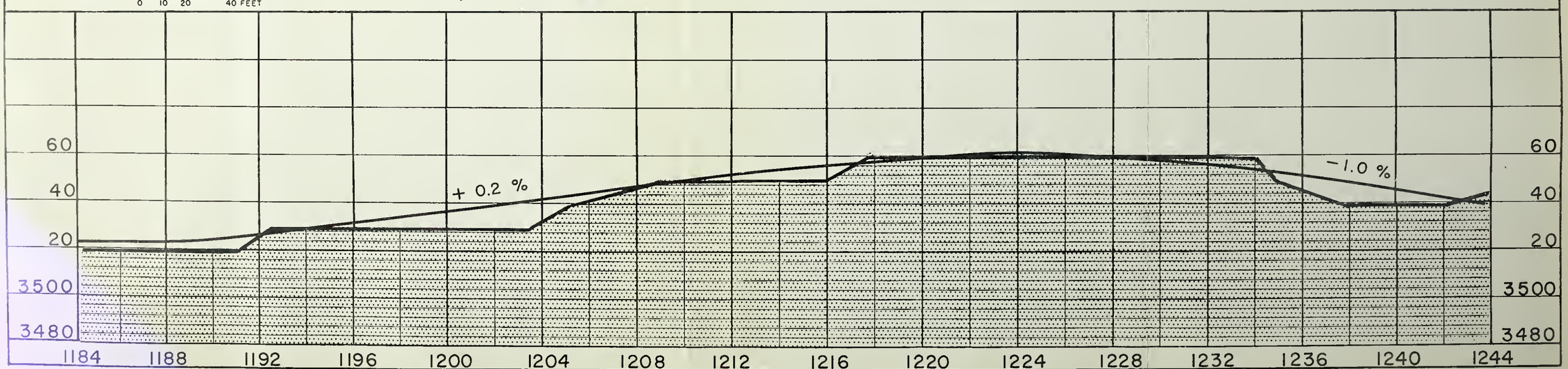
+ 0.2 %

1124 1128 1132 1136 1140 1144 1148 1152 1156 1160 1164 1168 1172 1176 1180 1184

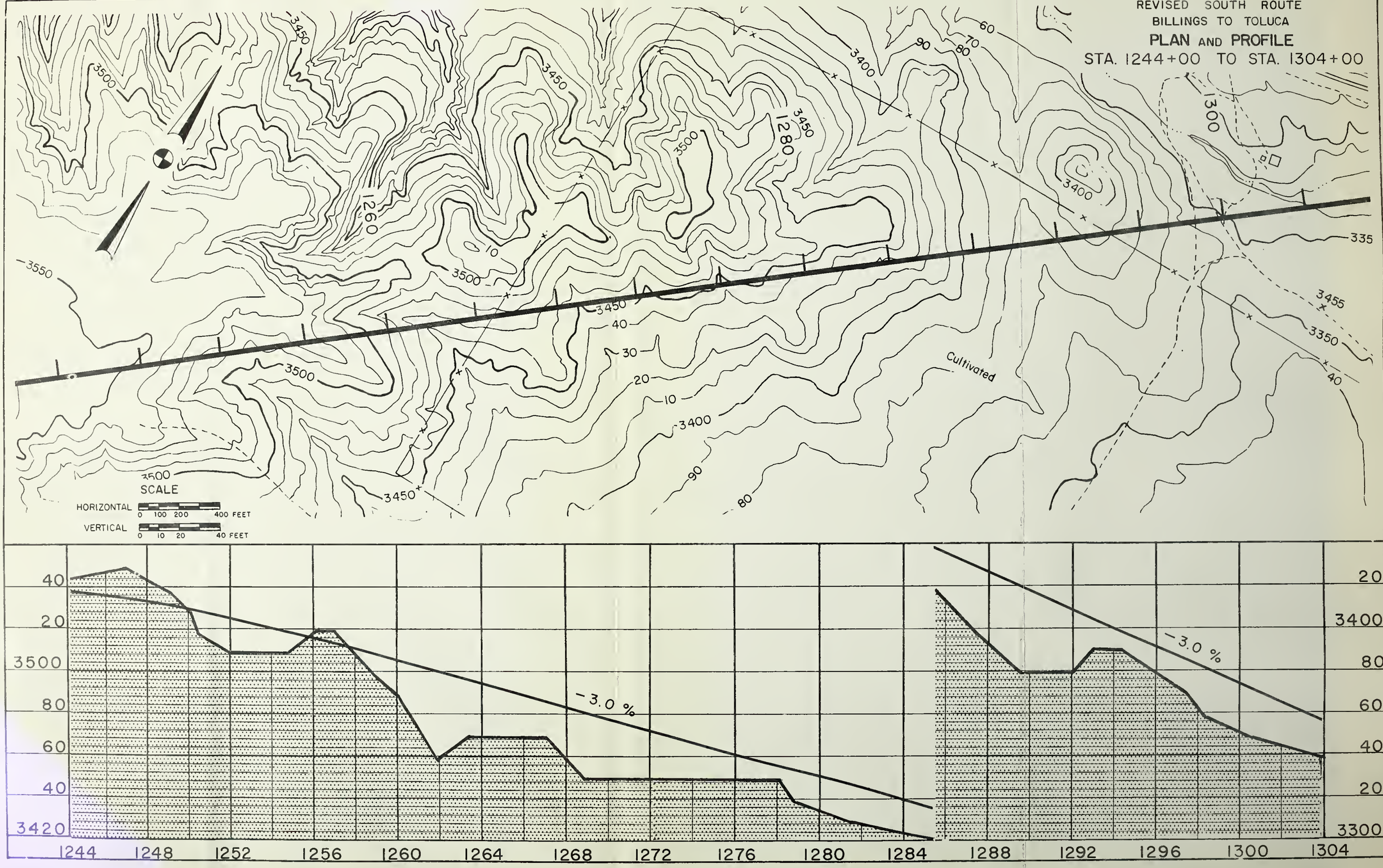
60 40 20 3500 3480

REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1184+00 TO STA. 1244+00



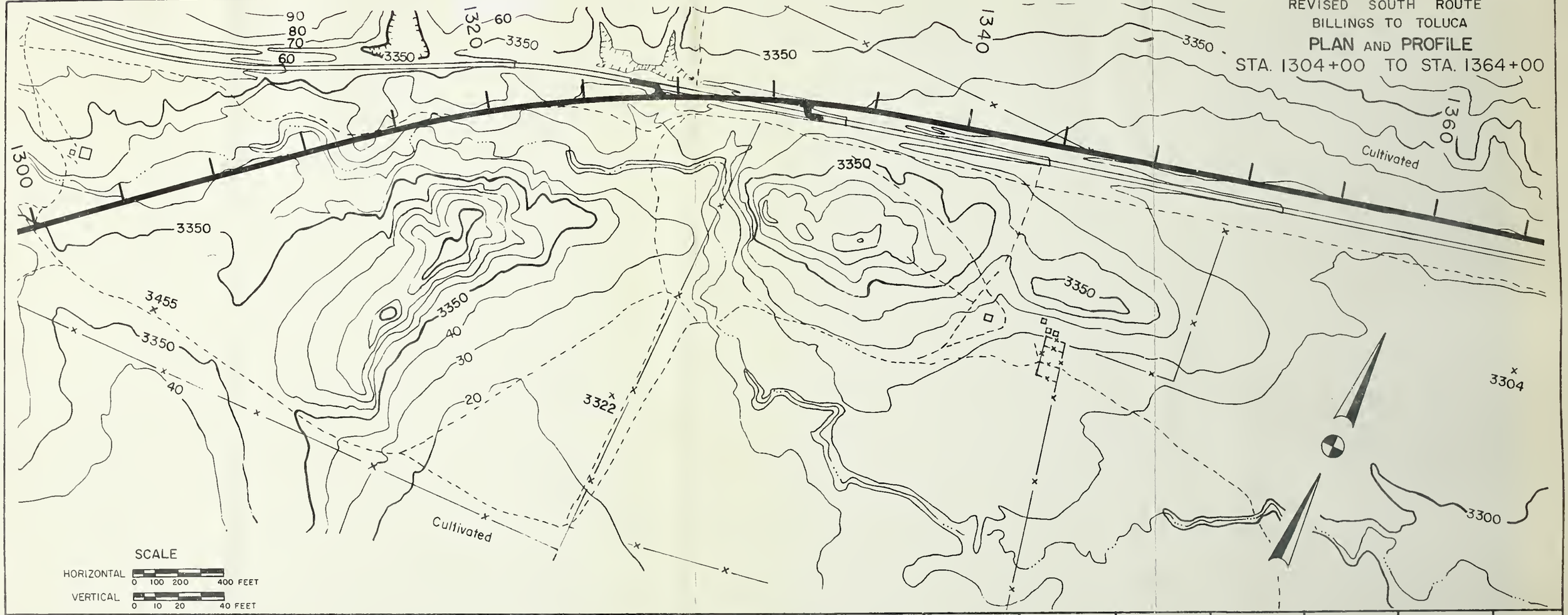


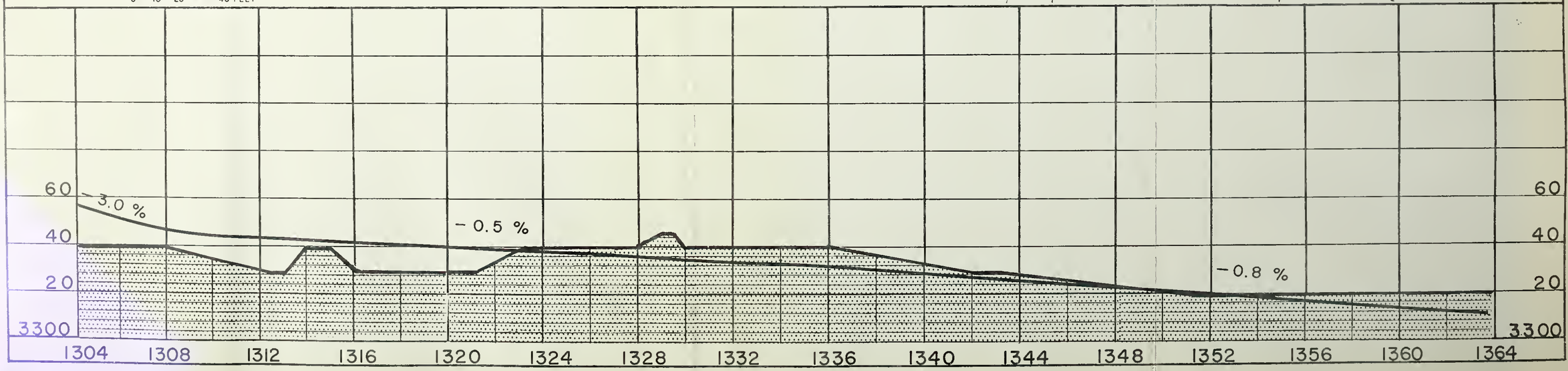
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1244+00 TO STA. 1304+00



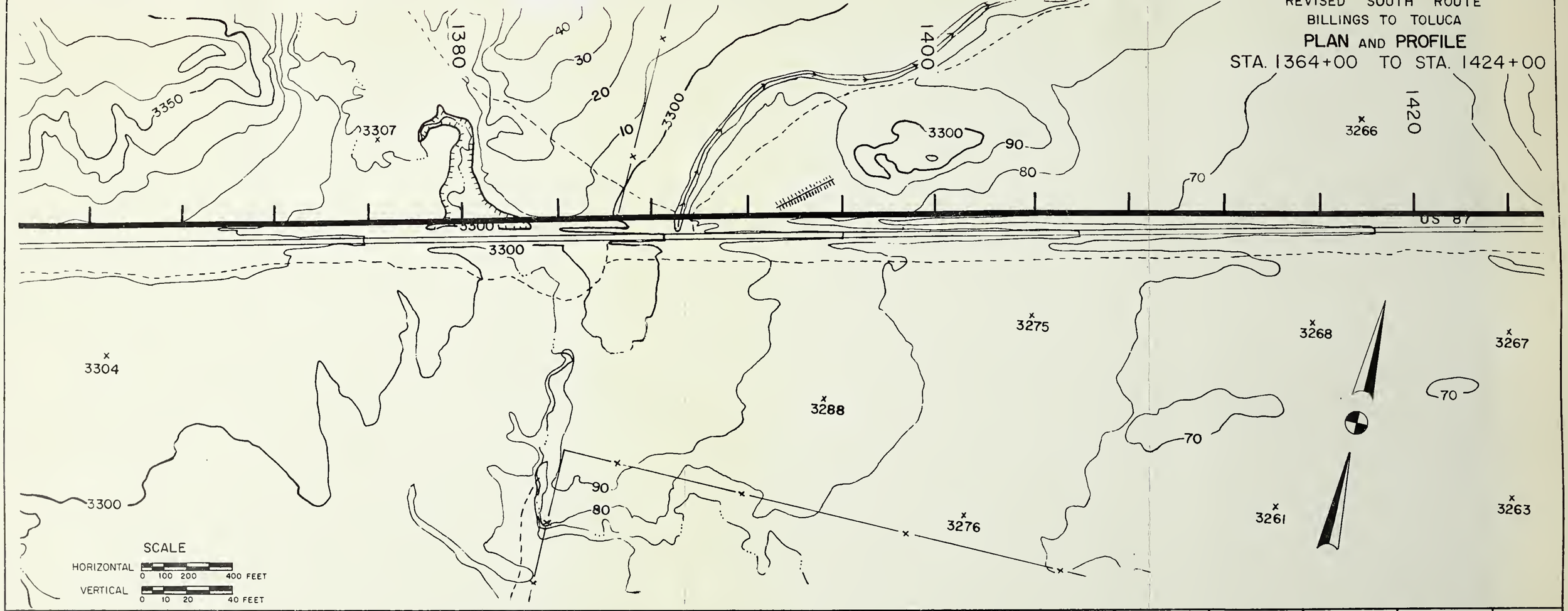
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1304+00 TO STA. 1364+00

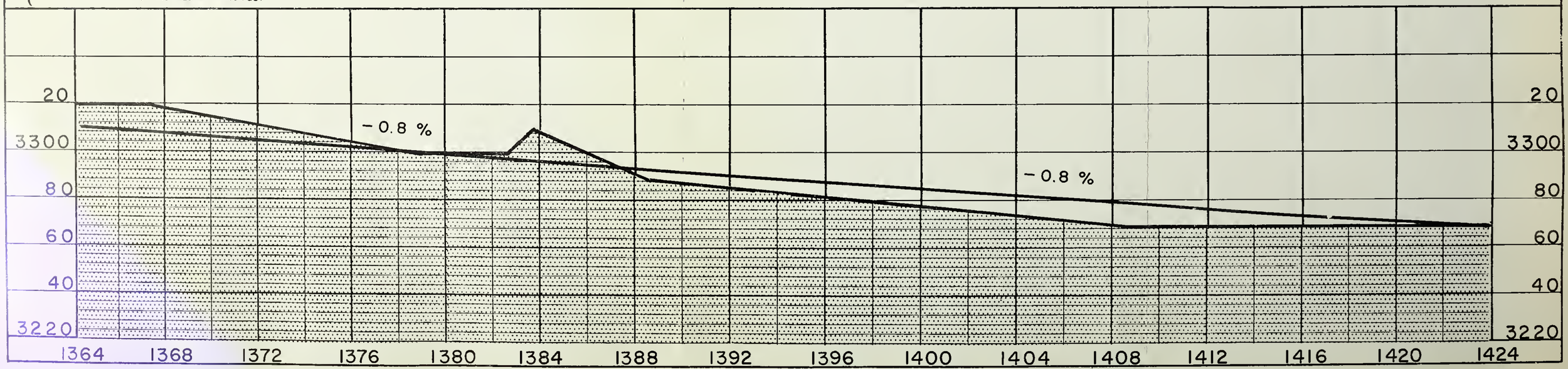
SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET


1300
1320
1340
1360
90
80
70
60
3350
3455
3322
3304
3300
Cultivated
Cultivated

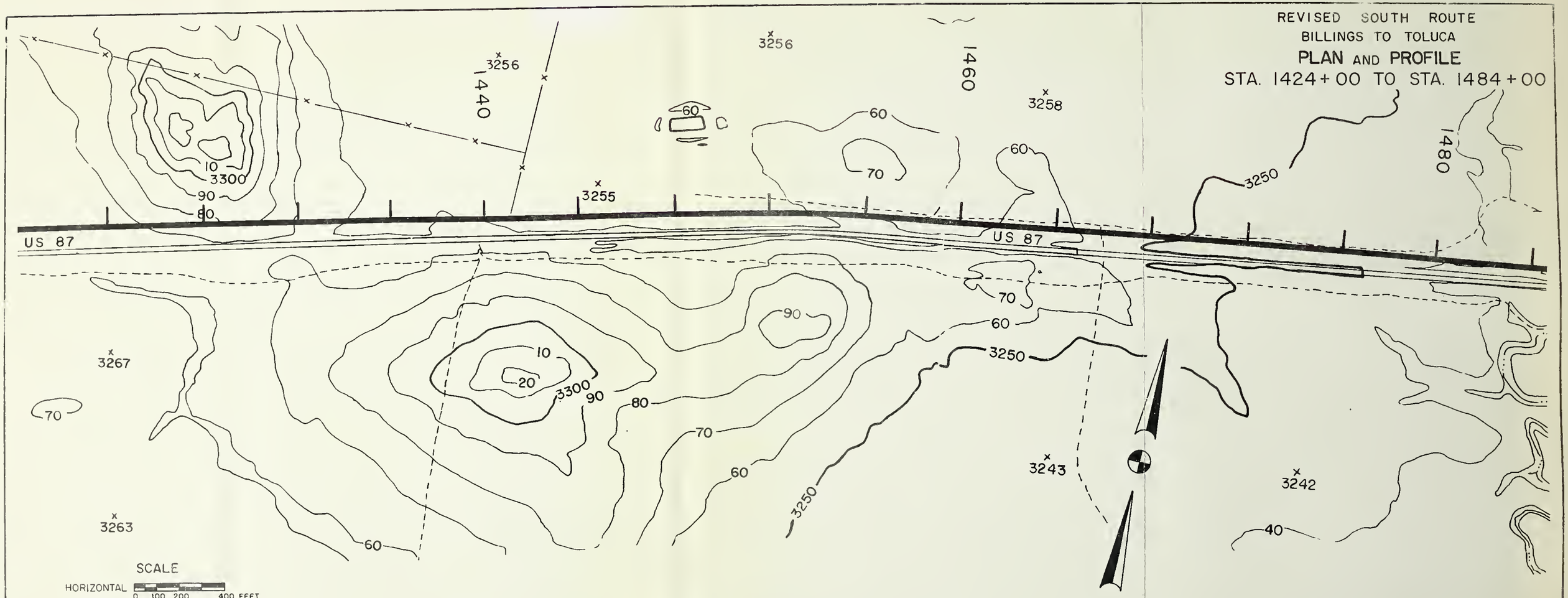


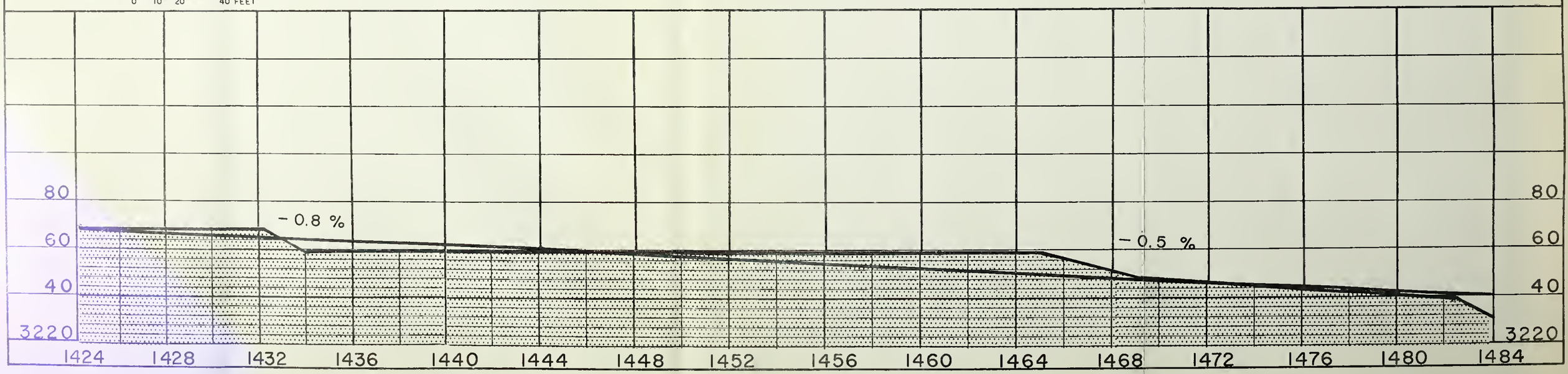
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1364+00 TO STA. 1424+00





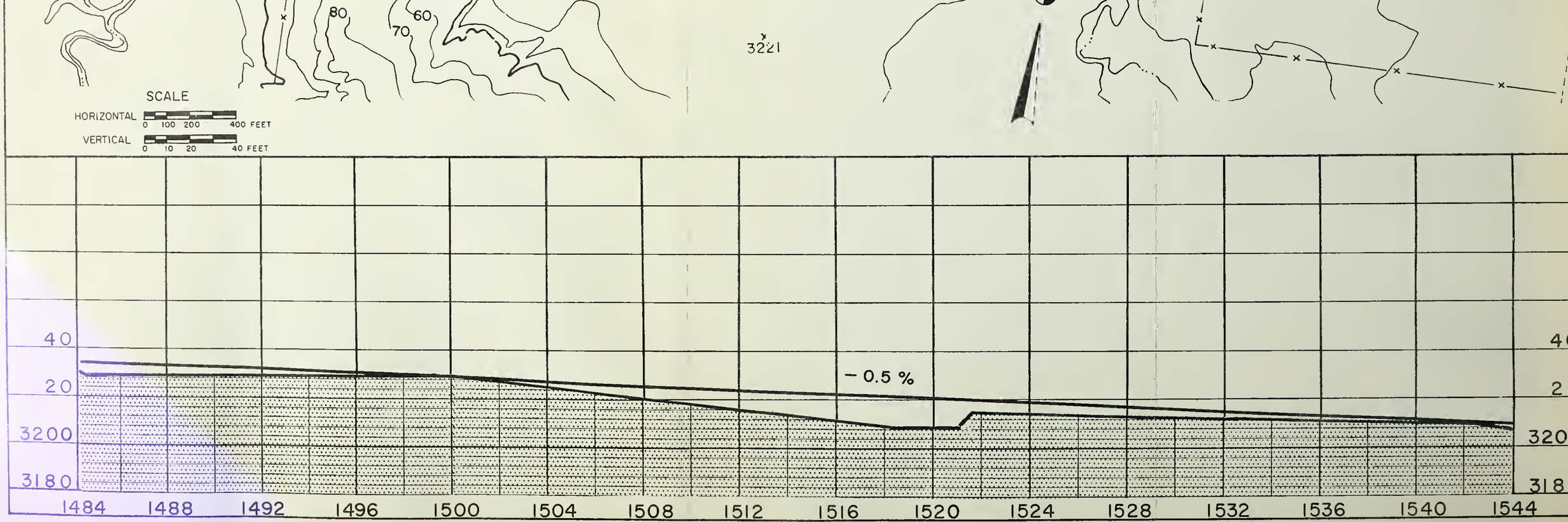
REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1424+00 TO STA. 1484+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1484+00 TO STA. 1544+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET



REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1544+00 TO STA. 1604+00

TO BALLANTINE

3205

1560

3196

3192

1580

3197

3197

Stock Pile

1600

3200

3200

90

3200

3202

90

90

3200 Res.

7204

30

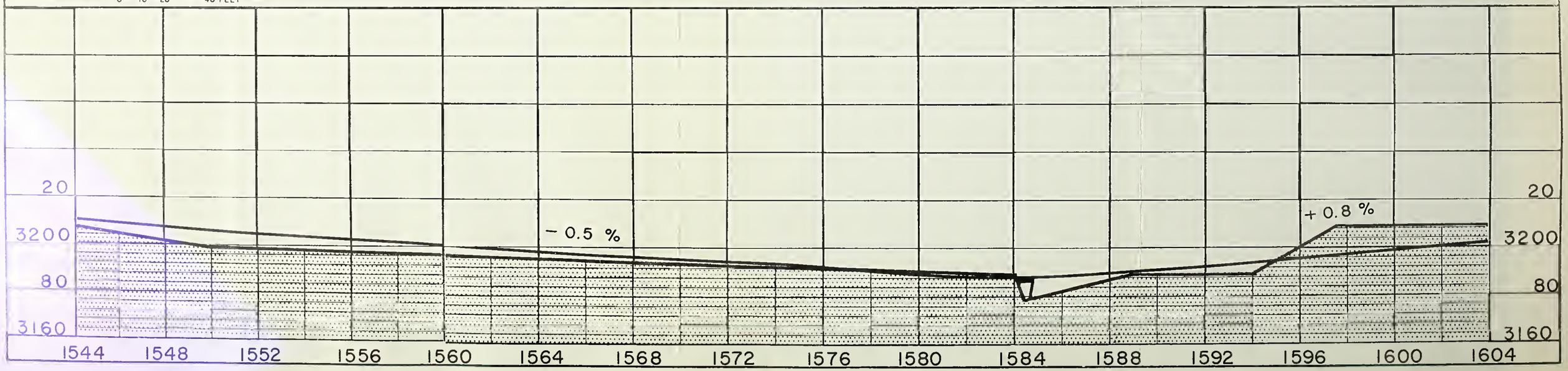
10

3200

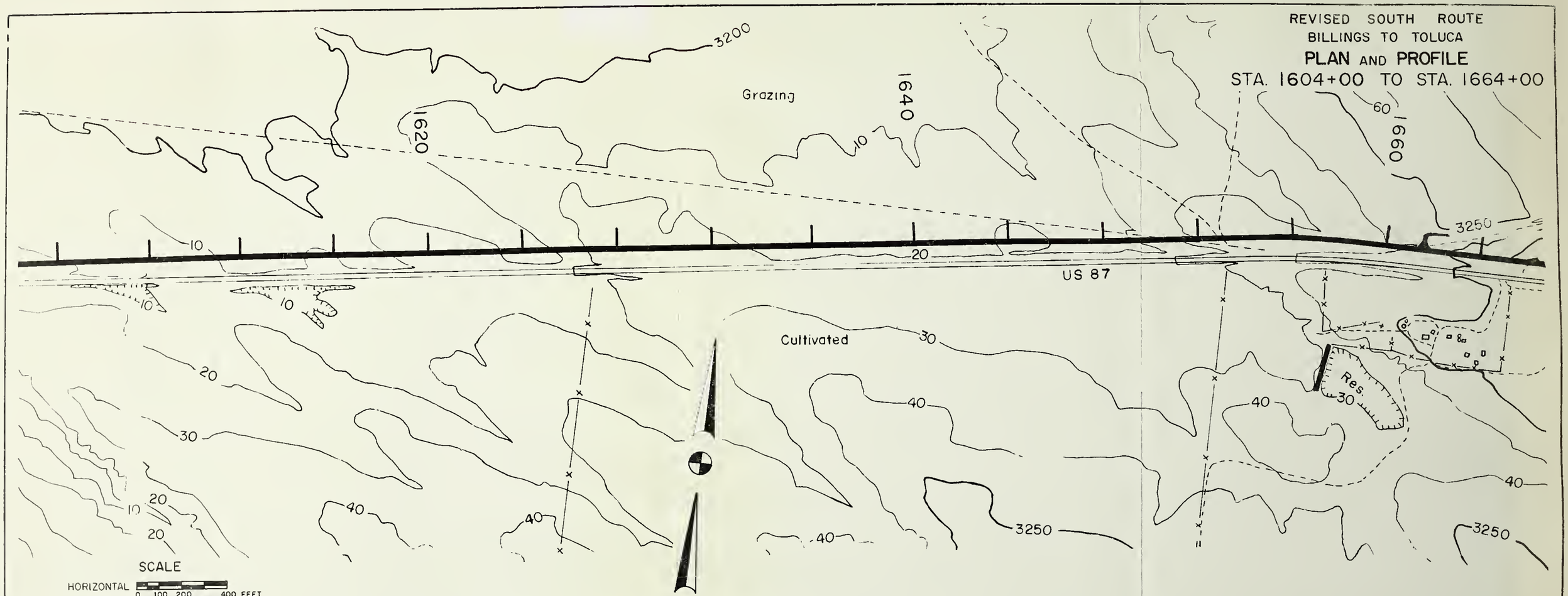
SCALE

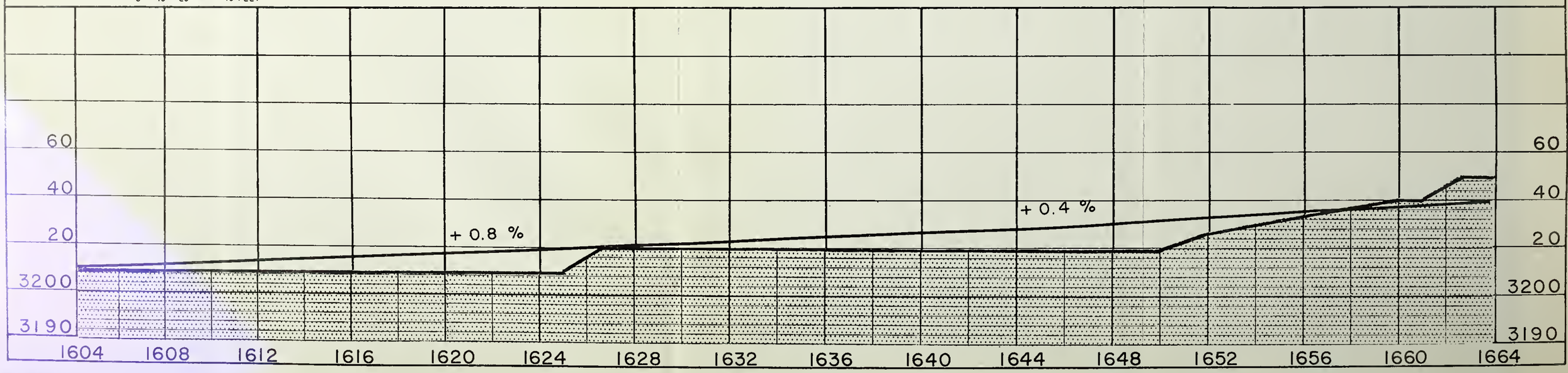
HORIZONTAL 0 100 200 400 FEET

VERTICAL 0 10 20 40 FEET



REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1604+00 TO STA. 1664+00

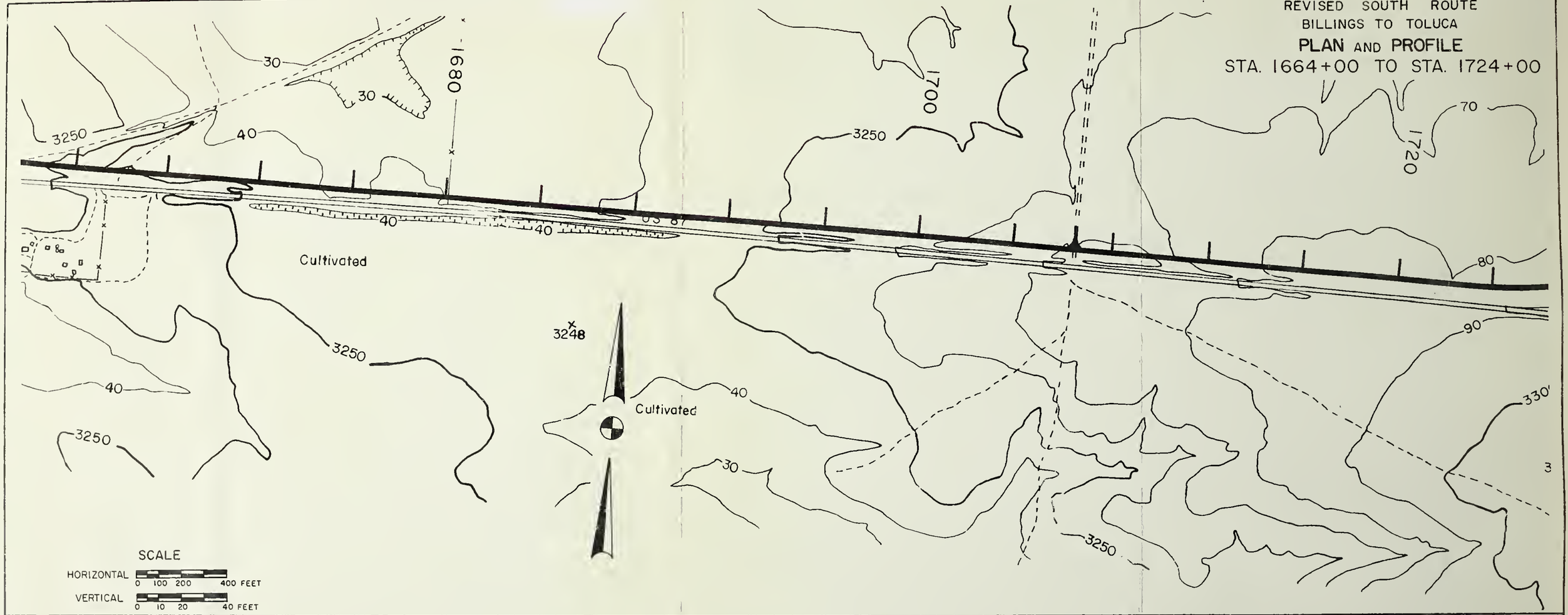


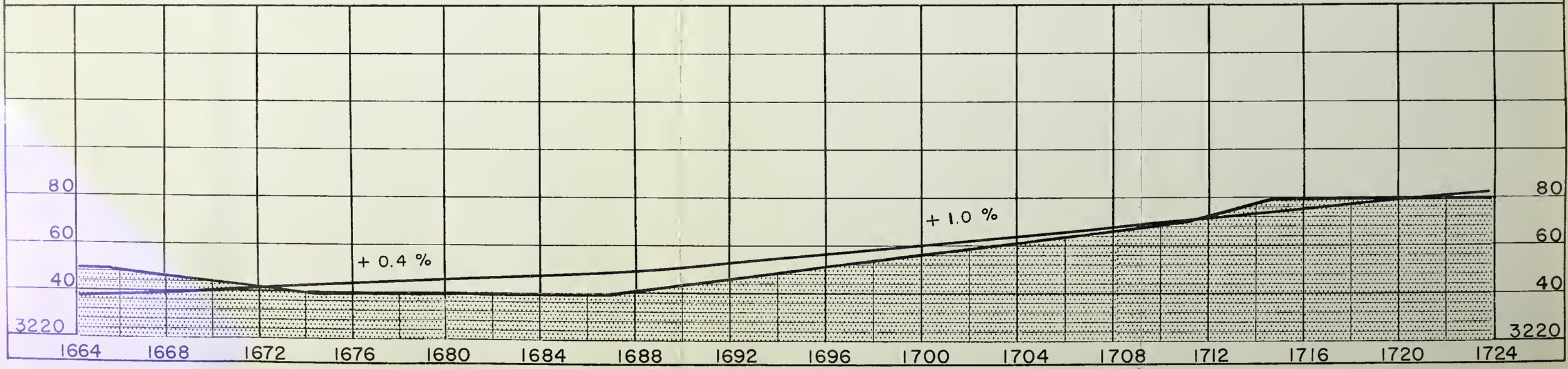


REVISED SOUTH ROUTE
BILLINGS TO TOLUCA

PLAN AND PROFILE

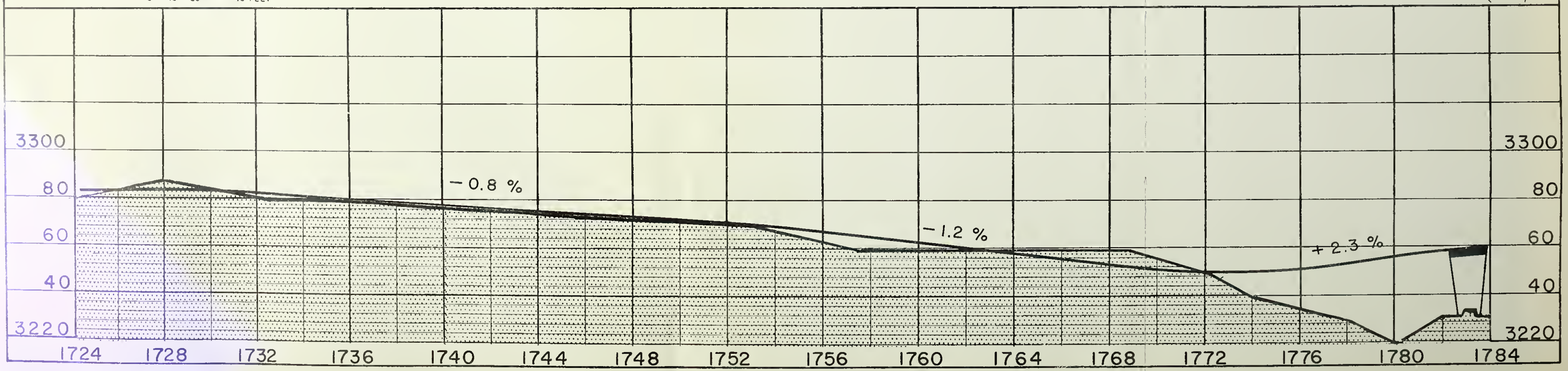
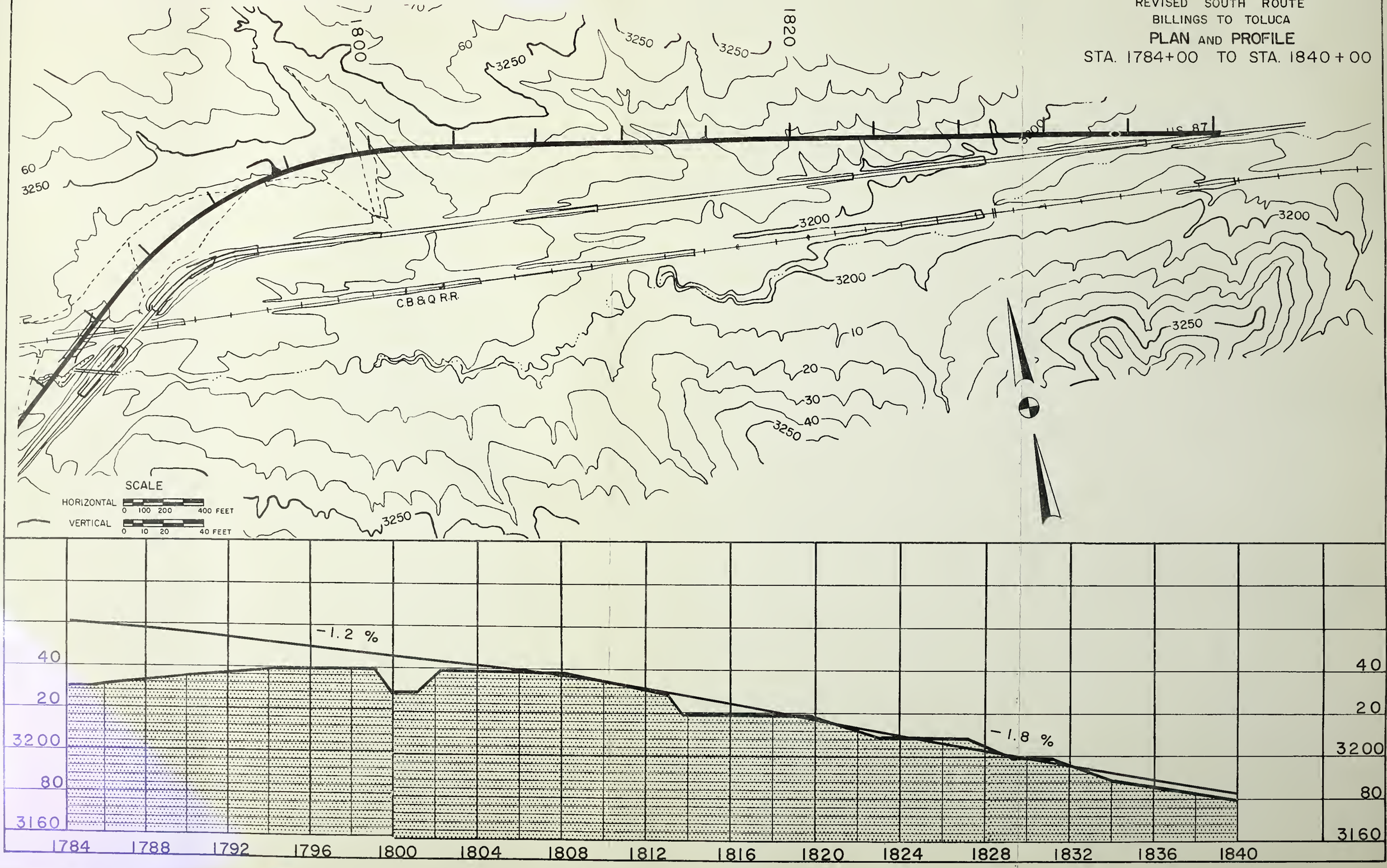
STA. 1664+00 TO STA. 1724+00





REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1724+00 TO STA. 1784+00

SCALE
HORIZONTAL 0 100 200 400 FEET
VERTICAL 0 10 20 40 FEET



REVISED SOUTH ROUTE
BILLINGS TO TOLUCA
PLAN AND PROFILE
STA. 1784+00 TO STA. 1840+00